TRAFFIC QUARTERLY

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OCTOBER 1952

Where to Begin
Theory of Traffic Control
Highway Safety Action Program
Parkington: Shopping Center Design
Land Value Along Houston's Gulf Freeway
Transportation Crises in Our Large Cities
Solving Parking Problems in Tennessee
Berkeley's Cooperative Parking Lot
Off-Street Parking in Columbus
Statistics for Traffic Analyses
Shopping Center Parking
The Grand Rapids Plan
Driver Psychology

THE ENO FOUNDATION FOR HIGHWAY TRAFFIC CONTROL

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Where to Begin

WHERE should we begin to improve our public driving? A short analysis of the problem may aid in answering the question.

Licenses in the fields of science or skill have an obvious meaning. Most of them are protective, and imply an obligation. They are eagerly sought, not easily acquired, usually treasured and jealously guarded.

They are not too different from your license to drive. It, too, may be the principal means of your pleasure or your livelihood.

Its issuance imposes two important obligations: one that you will comply with the laws and regulations pertaining to driving and second, that in its use you will conduct yourself in accordance with the moral laws of daily social usage, or courtesy and consideration for your fellow traveler.

Without a full understanding of these simple requirements and an honest resolution to abide by them, you should not accept your license.

Drivers can readily be divided into classes. The good and the bad, the ignorant and well informed, the careless and careful, the reckless and timid, the honest and dishonest. The roads are full of many of all of them.

Through the provisions of the licensing bureaus, vehicles are divided according to their use as commercial or pleasure. This affords a general division of drivers: commercial and pleasure combined with business or family chores. Each has its full share of poor drivers.

Enterprising concerns, particularly truck-fleet managers, have been quick to sense the advantage of schooled, well-trained drivers. They are especially conscious of its favorable impression on the public.

It is easy to spot them on the road and not unusual to hear other drivers praise them.

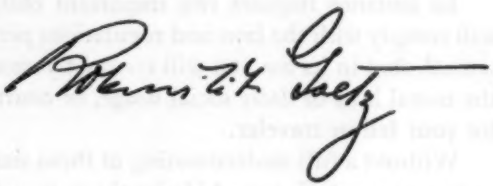
Aside from efficient management, those responsible deserve the recognition and gratitude of the public for their contribution to better driving.

Unfortunately the same opportunity for organized leadership, ease of control, and the challenge to excel does not exist and does not appear to be practicable with millions of private drivers. On any occasion for careful driving they are heedless of caution, counsel or fear, and are not deterred by death and distress on the highways.

Unquestionably our commercial drivers should be and are an outstanding group.

In any well directed and cooperative effort they have the wherewithal to set a national example for better driving and deservedly gain the approbation of the nation.

They hold in their hands a good place to begin.



Action Program for Highway Safety
A Design for Living

CHARLES SAWYER

Charles Sawyer, appointed Secretary of Commerce in 1948, came to the Cabinet with experience in business, law, and government. After being admitted to the bar with the top rank among 395 candidates, he has practiced law continuously, except for military and government service. He also has carried business responsibility including the ownership of eighteen newspapers and several radio stations. Secretary Sawyer has been active in government and politics: a member of the Cincinnati City Council; a delegate to several Democratic National Conventions; Lieutenant Governor of Ohio in 1932; Democratic National Committeeman from 1936 to 1944 and American Ambassador to Belgium and Minister to Luxembourg, 1944 to 1946. During his administration of the Department of Commerce, the Bureau of Public Roads and the old Maritime Commission (now the Maritime Administration) have been moved into the Department; an Office of Transportation has been established within the Department, and an Under Secretary for Transportation has been added. Under the guidance of Secretary Sawyer, the principal Federal activities dealing with transportation, which include those mentioned and the Civil Aeronautics Administration, have been concentrated in the Department of Commerce. In 1949 Secretary Sawyer, at the request of the President, presented a detailed report on problems involved in a unified program for transportation.

A LITTLE more than six years ago the President's first Highway Safety Conference met in May, 1946. Historically that is a very short period. Yet this six-year interval has revealed a number of significant developments in the field of traffic safety. Some are definitely reassuring, others cast a sombre shadow against the future.

We all remember the immediate postwar situation which prompted President Truman to convene the 1946 Conference. Back in 1941 traffic fatalities had reached a peak of 39,696, reflecting a death rate of 12.0 per hundred million vehicle miles. After Pearl Harbor wartime restrictions on motor car production and gasoline

rationing cut traffic fatalities sharply. With VJ-Day these restrictions were relaxed, traffic volumes shot up—and so did the death graph. Reports from all over the country made grim reading.

We again faced the prospect of more than 37,500 traffic fatalities in a single year, not to mention an appalling total of non-fatal injuries, and property damage far exceeding a billion dollars.

Then came the historic May Conference in Washington. The 2,000 delegates assembled there under no illusions. They had come together not to offer a magic cure-all but to draw up a sound, continuing program which the people of this country could act upon.

Action Program: Design for Living

The Action Program they developed was for home use—in every state and community—throughout the land. Delegates who were expert in different fields of highway safety pooled their knowledge and experience to put together in one package all the time-tested safety techniques that we need.

Eight technical committees drew up practical, down-to-earth recommendations covering these vital sectors of the highway safety front:

Laws and Ordinances
Accident Records
Education
Enforcement
Engineering
Motor Vehicle Administration
Public Information
Organized Public Support (now Safety Organization)

In addition, four other committees have lent powerful support. They are: A Federal Committee on Highway Safety; the State and Local Officials' National Highway Safety Committee; a National Committee for Traffic Safety representing some eighty-five national organizations and focusing primarily on the stimulation of public support for traffic safety programs; and a National Committee on Uniform Traffic Laws and Ordinances.

This many-sided and closely integrated attack produced an

Action Program which deserves to be called a Design for Living. It is aimed squarely at the toughest phases of the highway safety problem—a problem that involves the attitudes and behavior of some fifty-five million drivers and countless pedestrians. Equally important, the Action Program invites the cooperation of public officials, business organizations, and civic groups.

Action Program Reduced Traffic Deaths

How has the Action Program measured up, and what have the intervening years taught us about this nation-wide problem? When the second Conference was held in June, 1947, the traffic fatality rate was down to 9.8 and careful analysis of the organized safety movement indicated clearly that progress in successful states and communities went hand in hand with their application of the Action Program.

Analysis also showed that some states and many—far too many—communities had either neglected to follow the program or were going about it in half-hearted fashion. They were, in effect, placing a premium on death and disaster.

The Committee on Conference Reports met in 1948 and a great deal of solid work went on. The President's Highway Safety Conference issued an invaluable book called "Inventory and Guide for Action". Based upon reports from all of the states and some 600 cities, this inventory was both a record of progress and a careful summary of things left undone.

Some 2,500 delegates met at the third Conference, called by President Truman in June, 1949. The technical committees could report real progress and our national fatality rate was down to 8.1 per 100 million vehicle miles. Traffic deaths in 1948 numbered about 32,000 and marked the second successive year in which this toll fell below the figures of the previous year. And this was achieved in the face of a vast increase in motor vehicle mileage. The total rose from 249 billion miles in 1945 to 400 billion miles in 1948, a 60 percent jump.

Though the traffic fatality rate was down to 8.1, that national average embraced state rates ranging all the way from 12.1 to 2.7. And once again this spotty performance had its counterpart in safety

effort as measured against the Action Program. Those states and communities which had most faithfully carried out the program showed the lowest accident records. The reverse was true in those jurisdictions which paid only lip service to the Action Program.

Three-year Trend Reversed in 1950

During 1949 the death toll on our streets and highways was again reduced and the traffic fatality rate was cut to 7.5 per hundred million vehicle miles. But in 1950 this three-year trend reversed itself. Under the impact of sharply increased motor vehicle registrations and driving mileages both the total number of deaths and the fatality rate increased. The rising tide of accident exposure had outdistanced the organized traffic safety effort.

Moreover, this dangerous reversal took place against a background of national emergency touched off by the Korean campaign. As succeeding months added their harvest of death and destruction, the President called a 1951 Highway Safety Conference to meet in Washington, June 13, 14 and 15. The 2,500 delegates had before them reports of the technical committees and a careful inventory pointing out priorities in the Action Program. The record left no doubt that the program was sound and effective but it also demonstrated the hard fact that we had not achieved anything like full application of the basic program. Far from applying it "straight across the board," in many vital phases we had scarcely made a beginning. The over-all effort added up to only about 60 percent of what could be called an adequate, nation-wide safety job.

That is pretty much the situation we face today, when our country has an urgent need to conserve men and materials, when safe, efficient highway transportation is vital to national defense.

Last year 37,500 people were killed in motor vehicle accidents, an increase of 2,500 over 1950 and 6,000 over 1949. During the year more than 1,400,000 suffered personal injuries including 110,000 permanently maimed. The economic cost exceeded $3,000,000,000. This is an intolerable burden. Yet the steady increase in motor vehicle registrations and mileage presages a still grimmer future.

So far in 1952 traffic fatalities are some five percent above the

figure for the same period last year. And as the Bureau of Public Roads in the Department of Commerce has pointed out, there is an increment of transportation—including highway transportation—in every dollar of national income. Our economy will not remain static. It is growing and will continue to grow.

Motor vehicle registration has increased about 70 percent in the last seven years. There has been no corresponding increase in traffic accident prevention.

Emergency Conference Meets in October

That is the situation which faces me as General Chairman of the President's Highway Safety Conference. Wars have a beginning and an end. There is no foreseeable termination to the traffic accident problem. Let us approach it for what it is. Let us project a campaign of the scope and continuity which can embrace everyone responsible for safety on our streets and highways.

Drivers and pedestrians from coast to coast must be reached. Officials and legislators have their parts to play. Those who are active in the highway safety movement have a crucial role to fill. They are the catalytic agents who must spark the Action Program even as they take inventory of what is being done and what is being left undone.

All of us are answerable for this grim and tragic situation. Excuses and explanations have no place in the Action Program. That is how I see my responsibility as general chairman. And that is why President Truman has called an emergency meeting for October 17 and 18 in Chicago. A fundamental purpose of this Conference is to measure the problem and to see what our shortcomings have been in terms of the Action Program.

Looking beyond this objective to the persistent tendency that has yielded spotty application of the Action Program, I have invited an advisory committee of businessmen and industrialists to review the situation and develop recommendations for securing wider and more complete application of the Action Program.

Prior to the October meeting the secretaries of the technical and national committees will prepare a complete and concise summary

of the traffic safety picture for the Advisory Committee. This compilation will show clearly the full extent of deficiencies in each field, and the legislation, money and manpower needed for corrective action—action designed to make our safety effort 100 percent instead of 60.

The Annual Inventory of Traffic Safety Activities, the National Pedestrian Protection Contest and the High School Driver Education Award Program will provide the principal sources of basic information to be laid before the Business Advisory Committee and the forthcoming Conferences.

The Committee will include men outstanding in their respective fields, men whose demonstrated capacity for leadership makes them national figures.

The stature of these men is a measure of the contribution they are expected to make. As we look ahead and assign responsibility for safe, efficient highway transportation it is obvious that business and industrial leaders have a greater role than they have played so far. Both their stake in the nation's economy and defense and their potency as civic leaders give them a unique opportunity to spark the highway safety movement and inspire others to serve.

Without attempting to forecast what the October Conference will develop, here are several points that are sure to require special attention.

One point in particular demands very close scrutiny—accident records. The present lack of adequate accident information is hampering the entire traffic safety movement. We need much better and more complete accident records and we need to analyze them more carefully. This weakness has been emphasized in past reports of several Conference Committees, including the committee on accident records. Prior to the October meeting these groups are taking a new look at the problem with a view to developing a greatly expanded program.

Better enforcement is high on the list, particularly in rural areas. We know from experience that improved enforcement is a great shot-in-the-arm, probably the most important quick remedy. Today this all important work is seriously hampered by personnel shortages among both state and municipal police.

Better traffic court administration is an obvious must. And there is an equally crying need for more uniform traffic laws and ordinances. In the field of motor vehicle administration it is axiomatic that tighter requirements for driver licenses plus more uniform and thorough examining procedures would save many lives. Highway construction and design are long-range factors of tremendous importance.

These are formidable requirements and they impose equally heavy responsibilities. But the plain fact is that no matter how we approach the subject of highway transportation, the safe, efficient movement of men and materials has become of first importance to our national security.

Land Value Along the Gulf Freeway in Houston, Texas

HERBERT W. ELDER

Mr. Elder is a member of the firm of Norris and Elder, Consulting Engineers, Houston, Texas. He was formerly Supervising Urban Engineer in charge of Traffic Studies, Planning and Design, with W. J. VanLondon, Engineering Manager, Houston Urban Expressways. He worked for seventeen years with the Texas Highway Department, and was previously with the United States Bureau of Reclamation and with the United States Engineer Corps.

THE Gulf Freeway in Houston, Texas, is a controlled access traffic artery, which in every respect meets the American Association of State Highway Officials requirements for classification as a freeway. It is a multi-lane arterial trafficway with frontage roads on both sides, with access to the through-lanes provided only at interchanges. All crossings of the freeway are at grade separations for both highway and railway traffic, and it is the only fully controlled access traffic artery in Houston.

The facility is unique in other respects also, in that it is located along a route where no trafficway previously existed. It does not follow a railroad nor a stream so there were no barriers to prevent proper installation of interchanges with equal accommodation for all traffic from adjacent areas on both sides. The freeway begins near the central business district and extends to the city limits where it connects to a new interurban thru-way to Galveston. Because of the features outlined above and due to the facility's being one of the more important projects planned, designed and constructed since World War II, the Gulf Freeway was selected to serve as a "guinea pig" for this study.

What Data the Study Affords

The purpose of the study was to ascertain what effect the Gulf Freeway has had on the values of real property, 1. adjoining the facility

and somewhat removed from it; and 2. comparison with values of properties so far removed from the freeway as to be beyond the limit of any probable zone of influence. The work was done under the joint sponsorship of the Texas Highway Department and the U. S. Bureau of Public Roads with the Texas Highway Planning Survey as the directing agency. An engineering company of Houston was retained as consulting engineers and the study was conducted under the direct supervision of the writer, as supervising engineer.

As the study was to be objective it was essential that the basic data should be factual. As the most authentic data for showing true market values are actual bonafide sales of properties it was decided to use these as the basis for the survey and study. From the official records of one of Houston's largest banks were obtained complete data concerning all sales of real property made in the predetermined areas during each of the selected periods. The outline which follows shows the scope of the study, both as it relates to the areas included and the time periods covered by the survey.

Outline of Study

Basically the study includes surveys showing:

1. Land Values.
   a. Before the route of the facility was known.
   b. After the route became known and work was started.
   c. The latest available market value data.

The periods a, b, and c, cover the decade from 1940 to 1950, the first period being five years *before* and the last, five years *after* work was started on the Freeway.

2. Areas Studied.

a. Group 1, the primary area comprised of lands immediately adjacent to the facility.

b. Group 2, the secondary areas consisting of two bands of properties located, one on each side of and adjoining the primary group of areas.

c. Group 3, composed of lands somewhat removed from the

facility but accessible to it, and also accessible, via other good traffic arteries, to the central business district and to other sections of the city.

d. Group 4 includes areas widely distributed over all sections of the city except the southeast quadrant wherein Groups 1, 2, and 3, are located. All Group 4 areas are beyond the zones of probable influence of the Freeway upon land values.

3. Sectionizing of Group 1 and Group 2.

As the land use and land values vary greatly along the facility, these groups were broken down or sectionized according to types of development. These areas are of six types and the lines of demarkation between them are reasonably definite.

Section 1 is that nearest the central business district and the facility through this area consists of the "four street system" which is the collecting and distributing interchange for the west or city end of the freeway. This section abuts the downtown arterial streets adjacent to the central business area. It has some commercial property of long standing along these arterials, but in general consists of old residences, now obsolete, but once an exclusive residential area. It is now being given over to business and apartment house use, with considerable make-shift use of existing buildings for commercial purposes.

Section 2 was an area largely built up with low-cost, ill-kempt houses and a few light industries. Since the Freeway has been built, it is developing into an industrial and commercial district, particularly in the area adjoining the facility.

Section 3 was largely vacant land, much of which was bought by speculators soon after the route of the Freeway became known. This section has developed to industry very rapidly during the last five years.

Section 4 was made up largely of moderately priced homes. Their accessibility to the downtown area has been greatly improved by the Freeway. Almost all land in this area that was vacant in 1945 has now been improved with residences.

Section 5, except for one large subdivision, was largely vacant

land but is now being rapidly built up as a residential district. A considerable number of multiple unit apartments have been built near the Freeway since 1945.

Section 6 is an outlying community, and prior to construction of the Freeway had very poor access to the central business district of the city. The last section of the facility which will bring service to Section 6 was not open at the time of the survey. Benefits can be more completely shown by a future survey.

The Group Map, Figure 1, shows the areas included in the various groups and also the lines of demarkation between the six sections into which Groups 1 and 2 are divided.

Study-Method Obtained Facts

The basic procedure of the study method was planned to obtain detailed factual information to determine the market value of lands in all areas included in the four groups during each of the three periods selected. The time periods were chosen to cover a full decade, with the first period and the last period being respectively five years before and five years after the time when the Freeway became established as a potential factor of influence in the community. After the areas included in the groups had been determined as explained in the study outline, all sales of record made during each year of all three periods in all of the predetermined areas were obtained and assembled for analysis.

Authentic data covering 2,296 bonafide sales of real properties were obtained. The information as collected consisted of the legal description of the parcel, the date of sale, and the total sales price. The dimensions of each parcel, the assessed value of the land and of the improvements thereon, if improved, were obtained from city records. As the size of parcels varied greatly it was necessary to compute the area of each tract and reduce the total sales price to a price per square foot, so that a common factor could be applied to all areas.

The property transfers recorded are distributed among the four groups of areas as shown in Table 1, and the distribution during the three periods as shown in Table 2.

Table I

Group Number	*Number of Parcels*	*Total Area square feet*	*Total sales price*
1.	658	6,212,267	$ 5,439,561
2.	599	7,271,825	8,717,397
3.	335	2,838,554	2,283,605
4.	704	5,967,872	7,158,499
Totals	2,296	22,290,518	$23,599,062

Table II

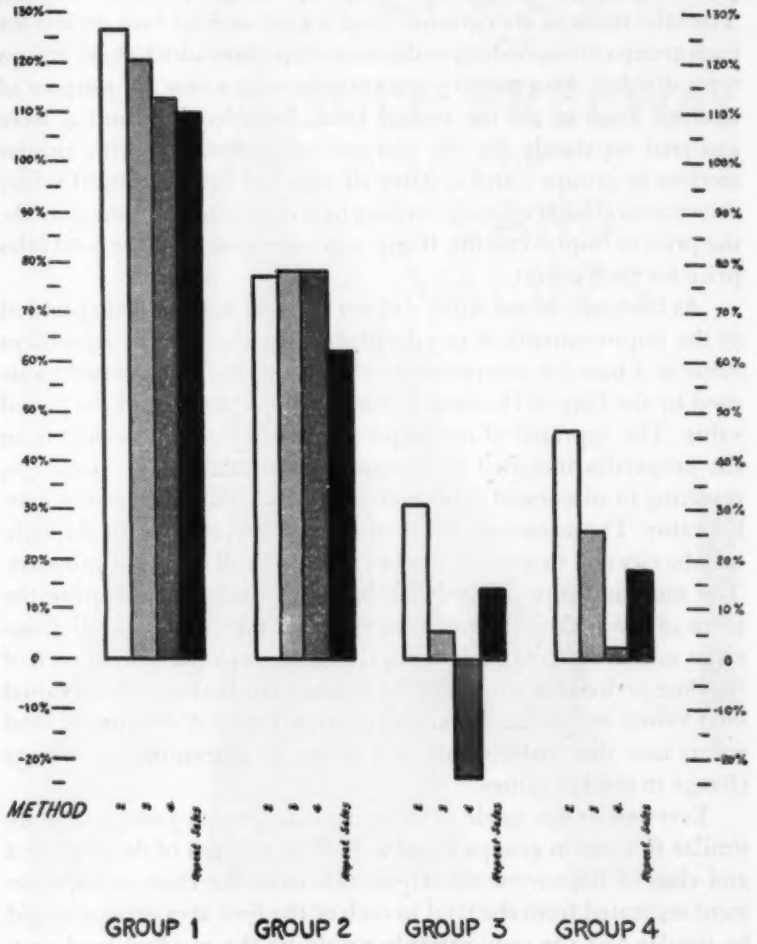
First Period	*Second Period*	*Third Period*	*Total*
1939–1941	1945–1946	1949–1951	3 Periods
858	1041	397	2296

During the first period, market values of property could in no manner have been affected by the facility because no planning had been done and field surveys were not begun until late in 1943. By 1945 the route was well established and much publicity had been given to the proposed project. Construction work was started during 1946, speculators began acquiring land near the route and other evidence of the Freeway's influence became apparent. The first section of the project was placed in operation October 1, 1948; additional sections were opened to traffic and construction started on others during 1949. By 1950 the impact upon the community became evident throughout the length of the facility.

The primary purpose of the study was to ascertain the effect of the Freeway on land values. Therefore it was necessary to separate the price of the improvements from the total sales price to obtain the residual land value. The groups of areas include highly developed business sections near the center of the city, blighted areas, and almost all other types of development. This made it desirable to reduce all sales prices to a square foot basis and all price changes to percentage gain or loss. This procedure places the property which increased from $5 to $8 per square foot on the same basis as that which increased from fifty cents to eighty cents per square foot.

The sales were arranged into four lots corresponding to the area groups and then further divided according to date of sale. This

COMPARISON OF CHANGES IN LAND VALUES IN THE SECOND 5 YEAR INTERVAL BY METHODS 2, 3 AND 4 FROM ALL SALES AND FROM VALUES OF LAND INCLUDING IMPROVEMENTS DETERMINED FROM REPEAT SALES.



DESCRIPTION OF METHODS

METHOD 2—Based upon separating the price of the improvements from the total sales price at the assessed value divided by 70%.

METHOD 3—Based upon separating the price of the improvements from the total sales price at the assessed value divided by 70%, multiplied by the factors based upon changes in the buying power of the dollar.

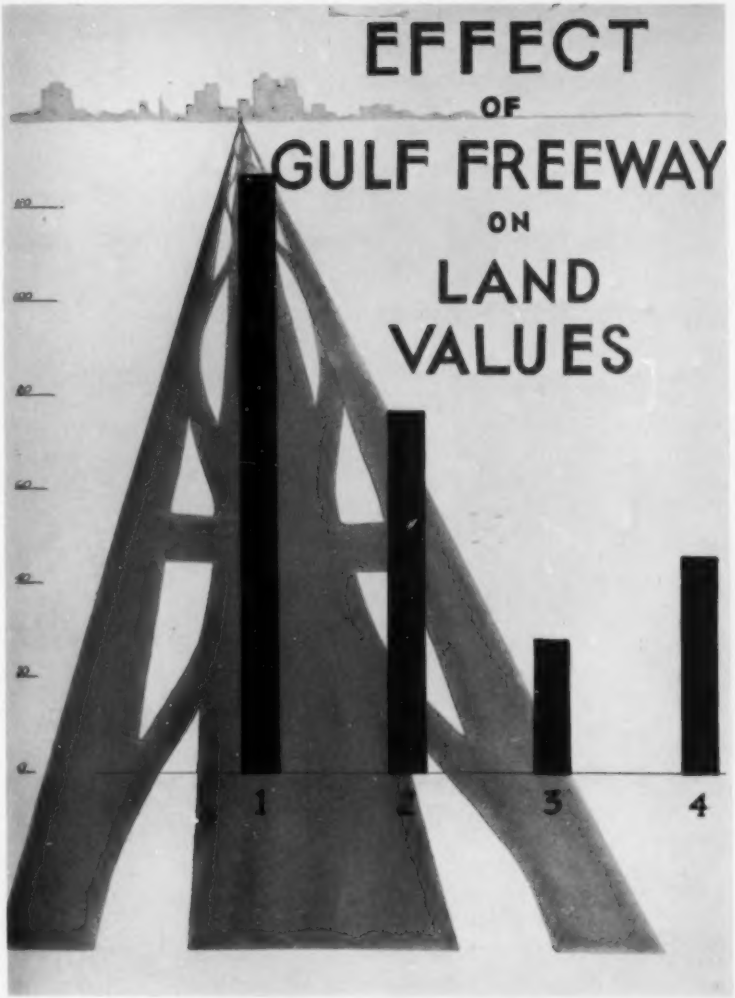
METHOD 4—Based upon separating the price of the improvements from the total sales price at the assessed value divided by 70%, multiplied by the factors based upon increased cost of construction.

REPEAT SALES—Based upon sales price with improvements.

procedure provided twelve basic groups of sales, one for each time period for each of the general area groups designated in the outline. The sales made in area groups 1 and 2 were divided into six lots for each group corresponding to the six sections into which those groups were divided. Area group 3 was considered as a unit for purpose of analysis. Each of the ten typical areas, included in group 4, were analyzed separately for the purpose of comparison with similar sections in groups 1 and 2. After all sales had been arranged under the various classifications according to area groups and time periods, the price of improvements, if any, was separated from the total sales price for each parcel.

As the scope of the study did not provide for detailed appraisal of the improvements, it was decided to use the city tax assessment value as a base for determining relative values. The assessed value used by the City of Houston is nominally 70 per cent of the actual value. The appraisal of the major portion of the improvements on the properties included in this survey was made many years ago, resulting in an assessed valuation much lower than the present market value. The assessment evaluation, however, is uniform throughout the city and in general, applies equally to all classes of property. The same measure or yardstick has been used for separating the price of the improvements from the total sales price for all properties sold in all areas, and identical procedures were used in each of the time periods for obtaining the residual land values. The residual land values are probably excessive, but actual dollar value of land enters into the analysis only as a means to determine percentage change in market values.

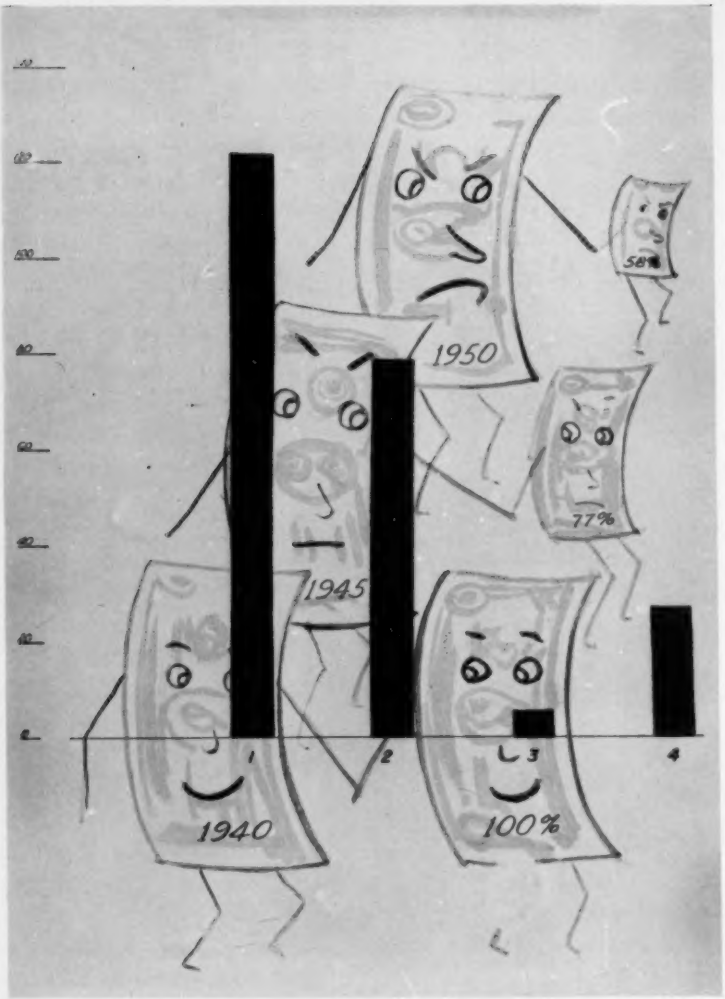
Every effort was made to select areas in groups 3 and 4 that are similar to areas in groups 1 and 2, both as to types of development and class of improvements. Upon this basis the class of improvement separated from the land in each of the four area groups would be similar and the only variable would be the residual land cost. This would vary with desirability of position. With these costs reduced to a percentage change from the *before* period to the *after* period for each group of areas, they reflect directly the effect of the Freeway upon lands located within the zones of influence of the facility as compared to lands in other areas.



COMPARISON OF CHANGES IN LAND VALUES

Based upon separating the price of the improvements from the total sales price at the assessed value divided by 70 per-cent. (Land Only)

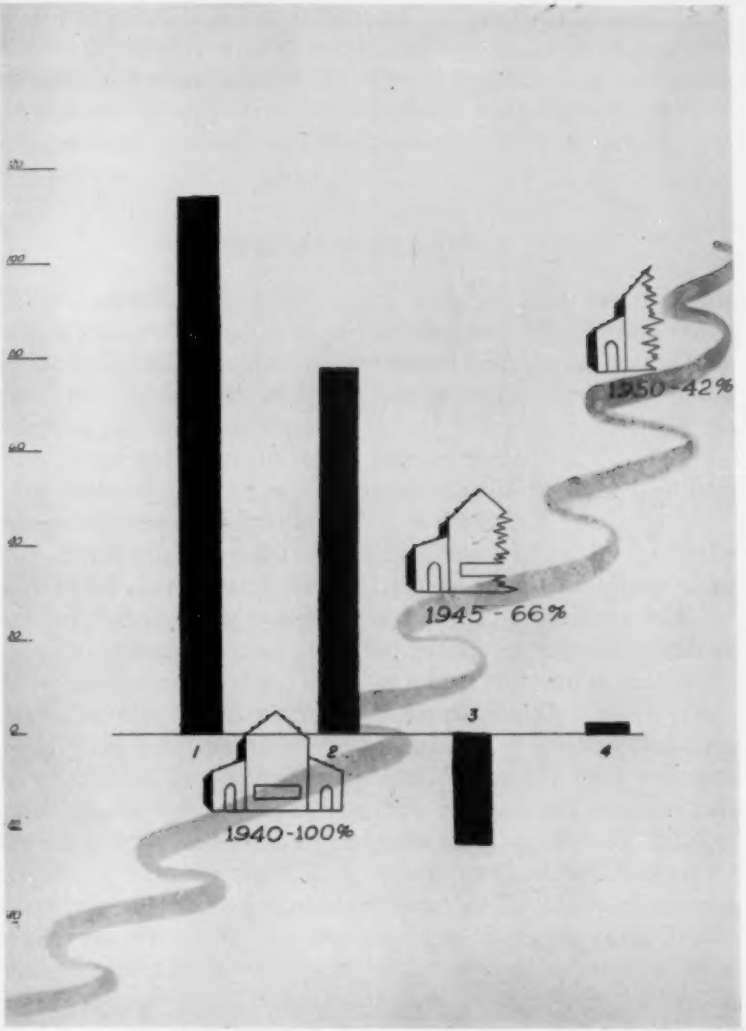
Percentage of the Gain or Loss During Second Five-Year Interval in each of the Four Groups of Areas. During this Period the Gulf Freeway Has Been a Potential Factor of Influence on Land Values.



COMPARISON OF CHANGES IN LAND VALUES

Based upon separating the price of the improvements from the total sales price at the assessed value divided by 70 per-cent, multiplied by the factors based upon changes in the buying power of the dollar. (Land Only)

Percentage of the Gain or Loss During Second Five-Year Interval in each of the Four Groups of Areas. During this Period the Gulf Freeway Has Been a Potential Factor of Influence on Land Values.



COMPARISON OF CHANGES IN LAND VALUES

Based upon separating the price of the improvements from the total sales price at the assessed value divided by 70 per-cent, multiplied by the factors based upon increased cost of construction. (Land Only)

Percentage of Gain or Loss During Second Five-Year Interval in Each of the Four Groups of Areas. During this Period the Gulf Freeway Has Been a Potential Factor of Influence on Land Values.

Forces other than the installation of the Gulf Freeway have affected the market value of properties. Two of the more powerful economic forces are changes in the buying-power of the dollar and increase in costs of construction. The first of these affects the price of both land and improvements, the latter affects directly only the cost of improvements.

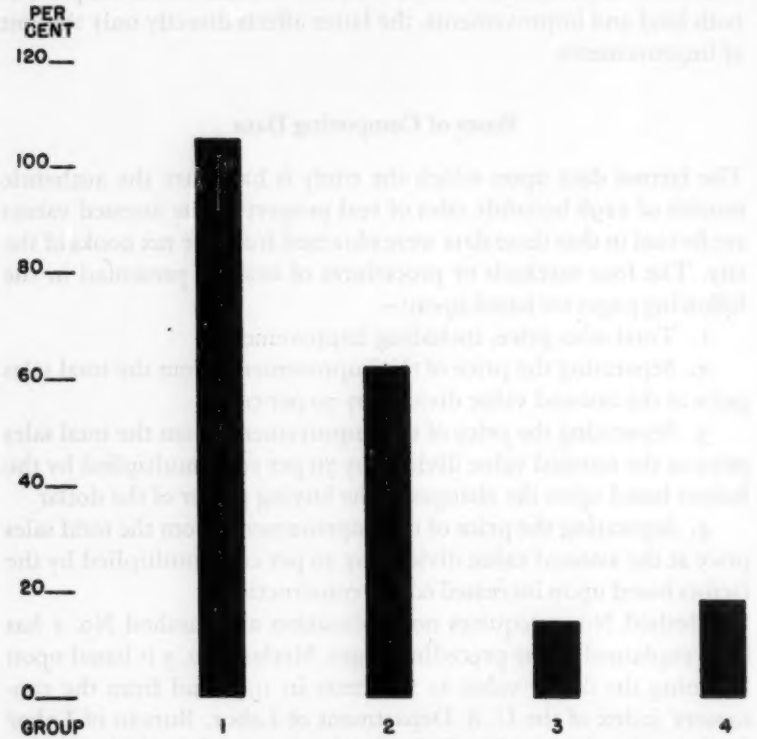
Bases of Computing Data

The factual data upon which the study is based are the authentic records of 2296 bonafide sales of real property. The assessed values are factual in that these data were obtained from the tax books of the city. The four methods or procedures of analysis presented in the following pages are based upon:—

1. Total sales price, including improvements.
2. Separating the price of the improvements from the total sales price at the assessed value divided by 70 per cent.
3. Separating the price of the improvements from the total sales price at the assessed value divided by 70 per cent, multiplied by the factors based upon the changes in the buying power of the dollar.
4. Separating the price of the improvements from the total sales price at the assessed value divided by 70 per cent, multiplied by the factors based upon increased cost of construction.

Method No. 1 requires no explanation and method No. 2 has been explained in the preceding pages. Method No. 3 is based upon assuming the dollar value as 100 cents in 1940 and from the consumers' index of the U. S. Department of Labor, Bureau of Labor Statistics, developing the relative buying power of the dollar for the second period, 1945–1946, at 77 cents and for the third period, 1950, at 58 cents. Method No. 4 is based upon assuming the assessed value of the improvements divided by 70 per cent to be par as of 1940. From the appropriate Bureau of Labor Statistics data the average increase in construction costs of the four classes of improvements, typical of those in the areas surveyed, were computed for the intervals from 1940 to 1945, 1945 to 1950 and for the decade from 1940 to 1950. These factors, used in the analyses as related to par in 1940, are 152 and 236, respectively.

The tables, charts, and graphs presented herewith show that by all methods of comparison used, the lands along the Freeway increased in value to a greater extent than did those lands located be-



Comparison of Changes in Land Values Including Improvements (Repeat Sales), During Second Five-Year Interval in Each of the Four Groups.

yond the zones of potential influence of the facility, the resulting percentage of change differing only in degree. As the only major factor of potential influence not common to all areas is the existence of the Gulf Freeway in the area showing the greatest increase in land values, it is certain that position relative to the facility has been largely responsible for the effect. Along one section of the facility the increase in land values during the *before* period was less than in

comparable areas in other parts of the city. However, during the *after* period, the increase was of such degree as to more than compensate for previous relative loss.

Among the nearly twenty-three hundred sales of properties, there were approximately two hundred "repeat" sales. By this is

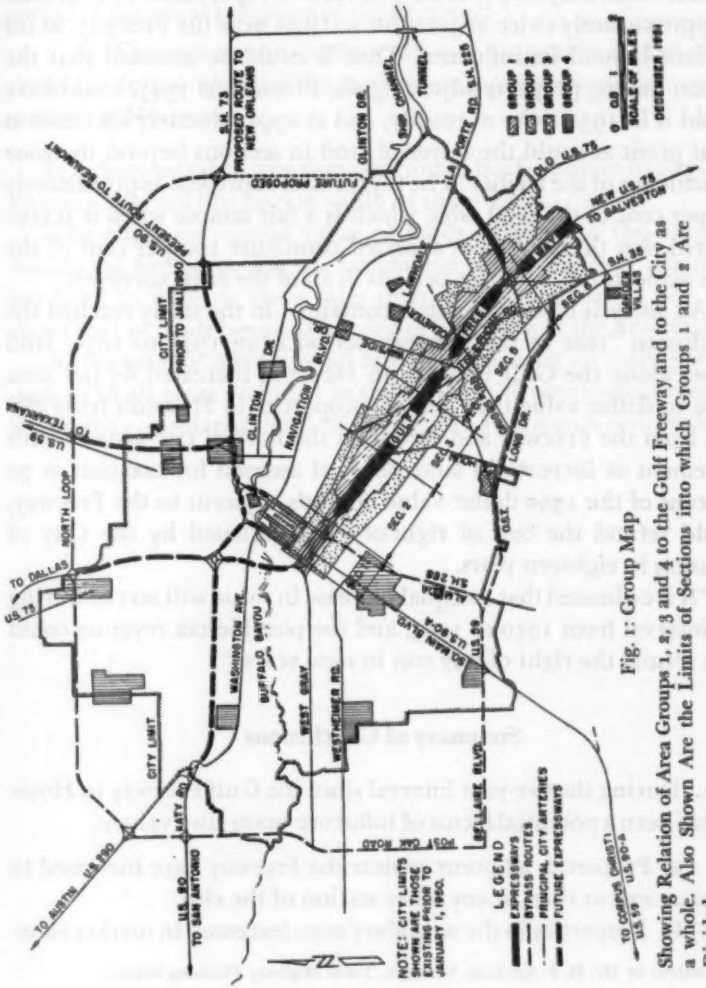


Fig. 1: Group Map
Showing Relation of Area Groups 1, 2, 3 and 4 to the Gulf Freeway and to the City as a whole. Also Shown Are the Limits of Sections into which Groups 1 and 2 Are Divided.

Study of Land Values and Land Use Along the Gulf Freeway

meant that identical properties were sold and then resold during two or more of the time periods studied. Analysis of these sales shows the increase in land values along the Freeway during the *after* period to have been 110 per cent. The same analysis shows that during this same period, lands beyond the influence of the facility increased in market value only 18 per cent. The ratio of repeat sales to total sales is approximately twice as great for sections near the Freeway, as for sections beyond its influence. Thus it could be assumed that the person buying property adjoining the Freeway in 1945, could have resold it in 1950 twice as readily, and at approximately six times as great profit as could the buyer of land in sections beyond the zone of influence of the facility. The repeat sales represent approximately 8.7 per cent of the total sales, which is a fair sample when it is considered that the 2296 sales analyzed constitute 100 per cent of the sales made during all three periods in all of the areas surveyed.

An analysis based upon data contained in the study reached the conclusion "that in the five-year period from 1945 to 1950, land values along the Gulf Freeway in Houston increased 65 per cent more in dollar value than similar properties in Houston lying distant from the Freeway and served by the normal city system. This increment of increase in land value, if assessed for taxation at 70 per cent of the 1950 dollar value of lands adjacent to the Freeway, would refund the cost of right-of-way purchased by the City of Houston in eighteen years.

"It is estimated that an equal increase in value will accrue during the interval from 1950 to 1955, and the possible tax revenue could then refund the right-of-way cost in nine years."[1]

Summary of Conclusions

1. During the five-year interval since the Gulf Freeway in Houston has been a potential factor of influence upon land values:

a. Properties adjacent or near the Freeway have increased to a greater extent than in any other section of the city.

b. Properties in the secondary zone increased in market value

[1] Analysis by Mr. H. P. Stockton, Manager, Texas Highway Planning Survey.

to a greater extent than did those farther removed from the Freeway.

c. By all methods of analysis used in the study, the relative changes in market value showed the same directional change, differing only in degree.

2. During the five-year interval immediately preceding the period of potential influence of the Freeway:

a. The increase in market value of properties in the areas along the future route of the facility was no greater than in other sections of Houston.

It is demonstrably true that position of lands relative to the Gulf Freeway affected the market value of these lands.

The effect on market value of lands adjacent to the Freeway during the five years that the facility has been a factor of influence has been to increase their sales price approximately 70 per cent above that of lands beyond the zone of influence of the Freeway.

As the sample comprises all sales made during all three periods studied in all areas included in the survey, the conclusions reached are positive, insofar as the Gulf Freeway in Houston is concerned.

Will Large Cities Finally Succumb to Transportation Crises?

WILBUR S. SMITH AND THEODORE MATSON

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TRANSPORTATION has done much to shape the character and control the growth-rate of American cities. The origin of cities is traced to the location of primitive trading posts on water routes, mountain passes, and land trails suitable for the early forms of transportation.

A city that does not exist largely because of its strategic location on routes of travel would be hard to find, and while transportation alone cannot make a city, it is equally true that a city cannot exist without transportation. Transportation controls a city's accessibility to its trading areas.

What Has Happened to Cities

Early American cities were restricted in area. Much travel was by foot and travel distances had to be short. A few tentacles developed along the better roadways before the advent of mass transportation, but the outward movement did not really begin until the horse-drawn and electric trolleys and mechanical transportation were introduced. One commentator recorded for the City Directory of San Francisco in 1875:

". . . . the modern horse car is to the city what the steam car and steamship lines are to state and country. In these days of fashionable effeminacy and flabby feebleness which never walks when it can ride, the horse car virtually fixes the ultimate limits of suburban growth."

Mass transit facilities immediately started suburban developments along extended transit lines, but a central core was still required because of the nature of the transportation. Since the '20s,

the automobile, accelerating the movement of people away from congested areas, has produced an entirely new concept of city planning. The radius of influence of cities has grown from a mile or two to fifteen or more. The city must serve the varied demands of this large area.

The successful growth of any given business district, while modified by many factors, depends largely on its accessibility to the surrounding trade area. This accessibility is determined by transportation and its operation. The future development of an urban area will depend heavily on its transportation facilities. Perhaps there is no area of the city that will be more affected by transportation than that entity known as the *central* business district (CBD).

The CBD, as its name implies, is a *unique* section of a city or trading area. Its purpose is to furnish a market for services and goods. The importance of such market is dependent on two major factors: (1) The quality and character of the services and goods; and, (2) the number of people who can conveniently avail themselves of goods and services. In recent times many changes other than in transportation have occurred in urban areas. Traffic has been only *one* factor, but an important one.

Population Shifts

Shifts in population produce changes in the character of cities. Cities grow in area as they grow in population, and as they adopt modern concepts of urban life. In the past generation their total populations have increased markedly. As populations became greater, densities actually decreased. Cities had to expand in area to make this possible. The cities that could most easily expand in area enjoyed the greatest increases in population. Philadelphia and Boston did not grow within their corporate limits as much as certain other cities. Since 1920, Philadelphia's population increased only 13 per cent, but the metropolitan area increased 35 per cent.[1] Between 1920 and 1930, Boston's total population grew only 4 per cent, but during the same period its CBD population decreased 30 per cent.[2] From 1910 to 1935, the population of Manhattan decreased 29 per cent; other boroughs had increases of more than 250 per cent.[2]

These population shrinkages in downtown districts are not

necessarily unhealthy indications. Often the movement of people from the CBD is a sign of business growth. People move out to make room for business expansion and to enjoy better housing and more attractive living conditions outside the old core areas.

Today outlying areas (suburbs) of all cities are growing much more rapidly than the central districts. Many of the large cities, hemmed in by other incorporated places are experiencing only slight growth because the urban growth occurs outside their corporate limits. The decentralization of population to the suburbs, especially if there results an asymetrical pattern of population distribution, interferes with the continuation of a single central core.

Assessed Land Values

Decreases in assessments within the CBD of large cities are another indication of significant changes. In all cities, the highest land values are still found in the CBD. While small in area, averaging little more than one-half a square mile each, these districts account for a substantial portion of property tax revenue, frequently one-third or more. Large declines were common in assessed valuations in CBDs in the recent years. During the ten years prior to 1946, Philadelphia had a 29 per cent decrease; from 1931–1945, Baltimore had a loss of 35 per cent.[3] In many cities, the declines were even greater.

Accumulations

The importance of the CBD can be partly measured in terms of the daily accumulations of people and vehicles therein. In most large cities both the daily number of people entering the central area, and the maximum accumulation of people have remained surprisingly constant. Changes have not even closely paralleled population growths. In some cities there have been decreases; Detroit, for example, had an 18 per cent decline between 1925 and 1940.[4]

A problem of accumulations has arisen because of changes in mode of travel. To accumulate the same number of people, many more vehicles are required than were necessary twenty-five or more years ago. With large decreases in persons, the number of vehicles may have increased, or decreased only in a negligible amount.

In the early '20s it was common to find that the number of vehicles entering the central core on an average day approximated the city's vehicle registrations. Today, cordon entries show that in most cities only about the equivalent of one-half the registered autos enter the downtown area daily.

Large cities record maximum accumulations in the CBD of from 12,000 to 15,000 vehicles on typical business days. Maximum accumulations of people may vary from 75,000 to more than 200,000.

Mode of Travel

With the popularity of automobiles people have changed their travel habits, especially in cities. Except for a temporary reversal during World War II, there has been since about 1920 a decline in transit patronage and an increase in private motor travel. In Boston, for example, the number of persons entering the CBD by mass carriers decreased 20 per cent between 1927 and 1938. During the same period, the number entering by private car increased 40 per cent.[5]

Preference for automobile travel is shown by a study of commuter transportation into New York City. In 1930, twelve per cent used cars and busses; in 1950, thirty-three per cent.[6] Even in congested areas like Manhattan the number of vehicles entering the area on an average week-day is increasing. In the last two years the number entering Manhattan has increased about 21 per cent.[7]

Land Use

CBD land uses have changed. Grocery stores are no longer found on Main Street. Many buildings have been razed for parking lots and open areas. The number of business establishments in the CBD has decreased in many cities. Vacant properties are relatively more numerous in these areas than in other sections of the city.

Since the central areas of cities are the oldest, it is natural that they frequently contain obsolescent buildings. They have buildings that are functionally inadequate, physically unattractive, and uneconomical to operate. Referring again to Detroit, it has been reported that 75 per cent of the blocks in the CBD contain buildings that are more than fifty years old.[4] Much of the street traffic con-

gestion in the garment district of New York City is attributed to the inadequacy of elevator capacity in the buildings.

Decentralization of Industry

There has been a substantial movement of industries to new locations or to the periphery of population pools. New processes and developments, labor, taxes, special concessions, and automotive transportation are the principal causes. This trend works against, rather than toward, helping the CBD.

Business Trends

In some large cities, substantial decreases are reported in the percentage of the city's total retail business which is transacted in the CBD. It is estimated that in Detroit the loss was $200,000,000 from 1930 to 1940.[8] Realty interests indicate that the CBD of some large cities lose about $50,000,000 per year to recent outlying developments. In 1935, the CBD of San Francisco did 6.6 per cent of the city's department store business; by 1947 this was reduced to 4.7 per cent.[9]

Some Reasons for Changes

Many of the changes that have occurred in the hearts of cities need no explanation. Reasons therefor are obvious. However, some of the factors contributing to changes are not so apparent, and in many instances, they are complexly interrelated. A few will be considered that are closely associated with transportation; there are others not directly related to transportation, if at all. A well known realtor recently claimed that crime is destroying property values in central districts of some large cities.

Merchandizing and Services

It is not the purpose to explore here the full significance of the services and goods available in business districts. It is noted, however, that with modern methods of mass production and nationally advertised brands, increasing percentages of consumer goods are standardized articles that may be placed in any market, at any location, and at nationally advertised prices.

Formerly, a consumer was required to go to a market and compare available qualities and prices of any article needed. Today, a well-known package of cigarettes, a soft drink, a can of beans, a suit of clothes, or an automobile, signifies a standardized article to the average consumer. There is great difference from the days of handcraft when even the manufacture of a single producer required comparison and study by the buyer before selection. With standardized brands, advertising and telephone communication for price comparison, the idea of a single market place loses much of its appeal even for standardized merchandise. A CBD, thereby, loses one of its major attraction qualities.

On the other hand, it is clear that special, non-standardized, and luxury goods that require careful comparison before purchasing, tend to anchor the CBD. Rare articles, or those for which there is no mass market, require a large population to make a market for such articles worthwhile. The efficiencies associated with rapid turnover of large volume of goods tend toward the maintenance of a single marketing area for large numbers of people.

Parallelism exists in the rendering of certain services. "Staple services" such as barbering, beauty shops, and even banking, need not require large areas of population for successful enterprise. But, specialists in law, engineering, finance and other professional services, demand large population pools from which they may draw sufficient clients in order to render services to mutual advantage.

It seems clear that the character of business in the CBD of the future will naturally gravitate, if not by adopted policy, toward the special, higher class of services, and away from the standardized staple goods of every day living, except insofar as a large volume of business may be attained.

Physical Decay

Another factor that tends to destroy the CBD is that of obsolescence of physical structures and blight of immediate surroundings. While patina and age may complement the handsomeness and beauty of structures of the past, a greater appeal to the masses in commercial enterprise today is found in the expression of "What's new?" Still further, the masses are attracted by lower costs that grow

out of functionally efficient structures and methods. Such improved efficiencies usually require new plant facilities.

Obsolescence, loaded with capital values and replacement cost, is found not only in the structures of private enterprise, but also in the public plan of streets and intersections. Yet these outmoded facilities which are an inheritance from the past must meet competition of other newer areas with higher attraction values and functional efficiency.

In development of policy for the healthy maintenance of a CBD, the obsolescence of plant, and the blight of areas in which it is submerged, become an important factor. If large volumes of business are to be attracted and efficiently dispatched in competitive enterprise, modernization programs of physical facilities are required.

Tax Gains

Because of *tax structure and assessment bases,* advantages may often be gained by the competitor who locates in suburban lands outside the government jurisdiction of the mother city.

Loose and inadequate zoning as well as antiquated building codes have done much to produce CBD problems. Too few cities have adopted and enforced comprehensive city plans that would have regulated and directed shifts and changes with minimum losses and difficulties.

Competitive Shopping Centers

The advantages and disadvantages of shopping centers in outlying urban areas will not be discussed. Business has followed the people. Stores and large shopping centers, far removed from the center of the city, have appeared in large numbers in recent years. A wave of shopping center development is currently underway.

Ease of access by private car and free parking are the principal attributes of these centers. They usually have a large key store as the nucleus, but many are complete, self-contained retail outlets, affording all the shopping opportunities of downtown.

Increased Consumption and Purchasing Power

Today national production is high. Per capita consumption and purchases are near the all-time high. In most cities the downtown

stores are doing a saturated business. This business is not impaired when they develop branch stores within the general area, as long as present demands exist. New retail outlets produce new business rather than diverting business from the old stand.

Transportation and Business Competition

The ability and ease of transportation to a given point may become the critical factor in decisions of a population as to where commercial and cultural activities may best be conducted. Transportation facilities of a community are of critical importance to that community. Assuming all other factors to be equal, the quality of transportation is clearly the deciding factor in competition for trade and service.

This competition extends not only among neighboring cities, but also among the various sections of a given city. Transportation policy of a given community becomes a matter of vital concern in the competitive position of the community.

Transportation Services

Modern transportation of people and goods requires flexible media that are swift, safe, and conveniently available. While economy of performance is desirable, especially in the movement of people, large masses place higher values on personal convenience and flexibility than on cost per mile.

In the urban transportation market several forms of transportation engage in competitive struggle to meet demands for movement. These include:

Private Means

1. Travel by foot
2. Bicycle
3. Private automobile or motorcycle

Public Means

4. Taxi cab
5. Motor bus
6. Trolley coach
7. Street car
8. Rapid transit vehicles including trains
9. Water borne vessels

Public *transit* is a service of large capacity vehicles operating on regular schedules and routes as a common carrier. Public transit in all its forms competes with private automobiles for a major role in urban transportation.

Trends in Urban Transportation

In the United States, the horse car started about 1831. In 1886, the electric street car was introduced; in 1873 came the cable car. Rapid transit, which started in Chicago in 1893* went subway for the first time in 1897 in Boston. About this time the automobile was introduced and by the time of World War I, it was commonly found in American cities.

During the first two decades of this century, the great majority of urban dwellers travelled by street car to work or business. Public transit was consolidated in most cities and became a regulated public utility. A "single fare and universal transfer" was achieved.

Since that time, the private automobile has increasingly come into favor by the urban public. Today it is the only important vehicle for local travel in many smaller municipalities. Even in cities of 100,000 to 500,000 population, an average of 70 per cent of travel is made to the CBD by motor car, and an average of about 40 per cent exists in cities over 500,000. Motor vehicle registration now exceeding 52,000,000 is still increasing rapidly and traffic on open roads (where it is free to expand) is growing at unprecedented rates.

Saturation of Automobile Use Not Yet Apparent

About half the travel by motor vehicles is on city streets. With the growth in use of automobiles, public transit has not developed heavier loads except in the war years. It is carrying about the same number of persons today (though at fewer rides per capita per annum) as it did in the twenties. While the subway and elevated systems have stabilized in both route mileage and rolling stock at about the same level since 1925, the motor bus and trolley coach have replaced most street cars and now include about 80 per cent of surface public transit vehicles, exclusive of rapid transit. At the same time, surface transit route mileage has increased from nearly

* The World's Fair.

80,000 to over 110,000 miles, or about 25 per cent. It follows, therefore, that with the same loads and greater route mileage, public transit lines have become thinner in many areas.

Even in spite of the shedding of capital investment, and the maintenance of about the same total passenger loads per annum, the per cent return per annum has fallen to an alarming low. With higher labor costs and operating expenses, without compensating increases in revenue, and with growing demands for private automobiles, the future of public transit presents a challenging issue to urban growth and development.

Urban Transportation Relationships

Time is of the essence in urban transportation. The limits of trading areas of a business district are primarily established by travel-time. Assume an hour (an excessively long time for most persons) is allowed; when walking, surface transit, and automobile are the modes of travel, the limits of trading areas are from three, to nine or ten, to fifteen or twenty miles respectively. Since the area of trade increases as the square of its radius, the trading area increases from about 30 to nearly 300 to more than 1200 square miles with the three forms of transportation. There results an intense struggle among cities whose potential trading areas overlap to gain the trade of the large area and to serve the entire population pool within reach by automobile travel.

Flexibility of travel is another basic quality of transportation affecting urban development. When street cars captured over 80 per cent of the travel, individual choice of route did not exist. One had to go where the tracks took him, usually toward the CBD on one hand, or toward the country on the other. Even at the peak of public transit usage, fixed routes and fixed time schedules never developed the flexibility of travel which is inherent in the automobile. The motor car permits choice of route as wide as the road net, and time of travel can become a whim of the individual.

Parking

Parking private automobiles is important to both the time and flexibility of travel. When parking space is inadequate at the origin

or destination of a trip, added time of travel and inconvenience result. Parking, coupled with increasing use of private automobiles, creates problems of congestion that destroy accessibility of the CBD.

Because of flexibility in choice of route offered the car user, opportunity is provided to establish satellite or outlying business districts in direct competition with the CBD. Such outlying business districts, because of undeveloped land and lower costs, may provide parking without charge, or at very low rates in comparison with the CBD. The very forces, both transit and private cars, which were major forces in creating the CBD, can now be directed through the use of motor bus and private automobile to the advantage of outlying business centers.

Anticipated Changes and Conditions

Looking at the changes in cities and the factors producing them, it is logical to think of conditions that will probably develop. Basic changes cannot be forced in human desires. Urban facilities must fit demands of the motor age.

More selective merchandising will be required in CBDs. Surveys of needs and forecasts will be made to relate business to transportation and other changing conditions. More thought will be given to such facts as: (a) Automobile customers make larger purchases (dollars) than others. (b) When their cars are parked off-street, customers buy more than when curb parked.

Better route and terminal facilities for automobiles will be developed. Earmarked Federal Aid for urban highways, public and private parking developments, tax adjustments to encourage parking facilities, and other current activities point the way.

As an aid to providing the needed facilities more rapidly, toll routes and more expensive parking facilities probably will be developed. Cities may test the willingness and ability of motorists to pay for improved and deluxe service.

Traffic technicians and professionals will be increasingly employed to study and treat problems.

It will probably develop that areas encompassing from 50,000 to 100,000 inhabitants will support separate retail centers, thus fractioning the larger cities as far as business districts are concerned.

Cities must reduce concentrations or stop using automobiles. There is no evidence that people will give up the motor car.

Transportation cannot be overlooked as a principal element in city life. It always has been and must always be. Private automobiles and motor trucks are increasing in numbers and in uses. All past predictions have been far too conservative.

Attempts to *require* the use of mass transportation have not been generally successful. There are some who say that the way to correct city traffic problems is to prohibit vehicular traffic in the congested centers, and to require people to use mass transportation or to walk. Already there have been many experiments with "fringe" parking and shuttle bus service downtown. In all except a few special cases, these attempts have failed. Even with cheap parking and subsidized riding, only a few motorists will use such facilities.

In general, business will continue to follow the people. If there are enough reasons for people to continue to "move out," business will follow them and will provide nearby, up to 90 percent of their needs, including many "special" needs. The more congested the main city, the more "following" will develop.

There still remain many untapped or potential uses of automobiles. These should be considered in developing new business areas and in replanning the CBD to avoid frustration which arises when new facilities become immediately overcrowded and existing conditions appear to remain unchanged because of new usage of automobiles.

Perhaps the time has come when cities must accept a condition of "maturity" for CBDs, although that is counter to basic desires for continued growth.

More care must be used in urban redevelopment, to let traffic fix the plan, rather than trying to have the plan fix traffic. For example, desirable "open areas" near the downtown fringe may not be at all suitable for parking for the CBD, even though it looks good in the overall plans.

Will the City Survive?

Unquestionably, cities will survive, CBD and all! Changes will continue to take place, but the CBD must be retained as the nerve

center and heart of the metropolitan community. Changes will take place at a slow but determined rate. They may be greatly retarded or accelerated by wars or by major national economic upheavals.

Plans have not yet been advocated that show a way to substitute for the basic city as center of governmental activities, cultural development, education, recreation, and highly selective retailing. It is a logical place for general employment, financial and professional services.

Urban conditions present many problems for public officials and administrators. For example:

1. Can CBDs be sustained? What are the great advantages in maintaining a single CBD?

2. Can the CBD adjust itself to meet parking demands in the light of changing modes of transportation? Is there enough space, irrespective of costs, in the CBD to accomodate increasing numbers of private automobile users? Are the efficiencies of centralization such that this parking space can be made available in competition with outlying districts?

3. To what extent should mass transportation become publicly owned? Should it be subsidized?

4. What are the relative public and private responsibilities in providing mass transportation? Parking? Expressways?

5. What constitutes access? If it is a public responsibility to provide streets for access, why not parking too?

6. What is the proper place of "public authorities" in various transportation areas?

7. Should toll routes be developed in cities?

8. How much and how rapidly can cities be decentralized for national defense purposes?

9. Do such things as rent controls and public housing hurt the city?

10. Will the construction of expressways and parking facilities have desirable effects on the CBD? Will they prove helpful or harmful in long-range developments?

11. How long can the central city continue to meet demands of new areas for municipal services?

12. The one big question—Can a satisfatcory form of govern-

ment coordination be devised for proper integration of the affairs of diverse communities, incorporated places, and other areas comprising large metropolitan districts?

This is not a new subject. Much has been written about it. Many prognostications have been made. Almost any answer one desires can be found and supported. Changes in cities have occurred, are currently in process, and will surely continue.

The exact nature of future changes, the rate at which they will take place, and the relative importance of the many factors involved cannot be predicted with certainty. It has been the purpose here to list and discuss significant observations and trends that may suggest ways of controlling changes so that ill effects can be kept at a minimum.

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Parking Plans for Shopping Centers

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Mr. Funaro is a member of a Chicago and New York firm of architects, planners and industrial designers. With this organization he has been associated in the design of several shopping centers. He is a lecturer at Columbia University and co-author (with Geoffrey Baker) of "Shopping Centers—Design and Operation." He is a member of the A.I.A.

THE American housewife has discovered the great convenience of using her own automobile to drive to stores and bring home her purchases. And for merchants her discovery has reduced the cost of delivery.

After struggling for years with no-parking signs and parking meters, she finds in shopping centers with almost unlimited free parking a realization of her shopping dreams. And conveniences besides free parking are in store for her: among them, parcel pick-up stations and auto-shopping facilities.[1]

In a shopping center, depending mostly on customers coming by automobile, the design of the parking area—which may have to cover 80 per cent of the site—is more than a matter of traffic engineering; it is integrated with the site plan and the design of the stores proper.

How Much Parking?

The first question in the mind of the developer of a new shopping center is "How large should the parking area be?" An answer, even an approximate estimate, is essential before a center can be planned. Obviously, the parking demand of a shopping center is directly re-

1 "Traffic Planning Opportunities in Shopping-Center Design," Howard T. Fisher, Traffic Quarterly, Oct., 1951.

Wurdeman-Becket, Architects

Photo by permission of Julius Shulman, Los Angeles, California

A landscaped parking area at the Bullock's-Pasadena Shopping Center in Pasadena, California.

Architects: Ketchum, Gina and Sharp

Shoppers' World, Framingham, Mass., at peak of parking demand. Land in reserve could double present parking area.

lated to the extent of the sales volume of the given kinds of stores within the center.

On the other hand, insufficient parking will prevent a shopping center from reaching the maximum productivity. The merchant who wishes to produce his maximum December sales, when he makes an important part of his annual profit, must care for all the customers who come then. When these customers furnish their own transportation and parcel carriers, the merchant must furnish adequate parking.

"If you do not, and customers are turned away," warns Juston Rawls, developer of *Shoppers' World,* "they may not try it again." Evidently, when land is abundant and cheap, it is safer to provide parking in excess of the demand rather than risk curbing the productivity of the stores because of parking deficiency. The question, "How much parking" should, in effect, be divided into three different questions:

1. How much parking will be required at the weekly peaks (which generally occur on Saturday mornings or on those nights on which the stores stay open late)?

2. How much parking will be required at the peak of the Christmas shopping and of special events?

3. How much parking in excess of the current needs should be provided to meet future increases in parking demand which may be due to increased productivity of the stores, changes in shopping habits, and expansion of the stores?

The reason for three separate questions lies in the fact that we are dealing with three physically distinct areas. The parking area used regularly requires lighting and landscaping in quite a different manner from that of the area reserved for overflow parking used on a few occasions during the year. The land earmarked for future expansion could be kept unimproved until the demand for it seems imminent.

Realistic answers to these questions can be obtained only from observation of the actual performance of shopping centers in operation for years. The new large regional centers will undoubtedly provide useful data. So far, whatever data are available are incomplete and often misleading because these centers, open too short a

period, have not yet reached their full productivity. Statements of a general nature, however, can be safely made.

The parking demand, with weekly and seasonal fluctuations, has followed a similar pattern in centers similar in size and types of store. Differences in parking demand can be traced to foreseeable causes such as the extent of public transportation, prevailing types of stores, and the size of the center.

For a good-size suburban regional center, about 500,000 square feet of gross store area, depending almost entirely on shoppers coming by private car, with at least one, perhaps more, department stores, the maximum demand during a typical week will probably have an index of 5. During seasonal peaks it can rise to 10 or more. An index of 15 should be provided for a properly balanced center, which sells 85 per cent shopping goods and which depends over 95 per cent on automobile transportation, when this has reached 90 per percent of its top productivity.

Parking Index

The most generally accepted parking index for a Shopping Center is expressed by the number of car spaces per 1000 sq. ft. of gross operating floor area of the stores including the floor area of basements, mezzanines and upper stories, but excluding service area outside of the stores, such as boiler rooms and freight tunnels. For example, a center with 200,000 square feet of gross store area and with 1500 parking spaces has a parking index of 7.5 ($\frac{1500}{200} = 7.5$).

Geometrics of The Site Plan

Excessive emphasis on the extent of parking may become meaningless unless the parking can be fitted into the site plan. It is evident that the more the parking area is increased, the further it stretches away from the stores until it will reach a distance beyond which its parking value becomes nil. How far can the usefulness of the parking field extend away from the buildings will depend on a variety of circumstances. They include the eagerness of the shopper, the weather, and what other centers offer within the region.

For design purposes, let us assume 400 feet as the maximum parking distance from the outer fringe of the parking area to the stores, for regular (everyday) parking and 650 feet (three minutes

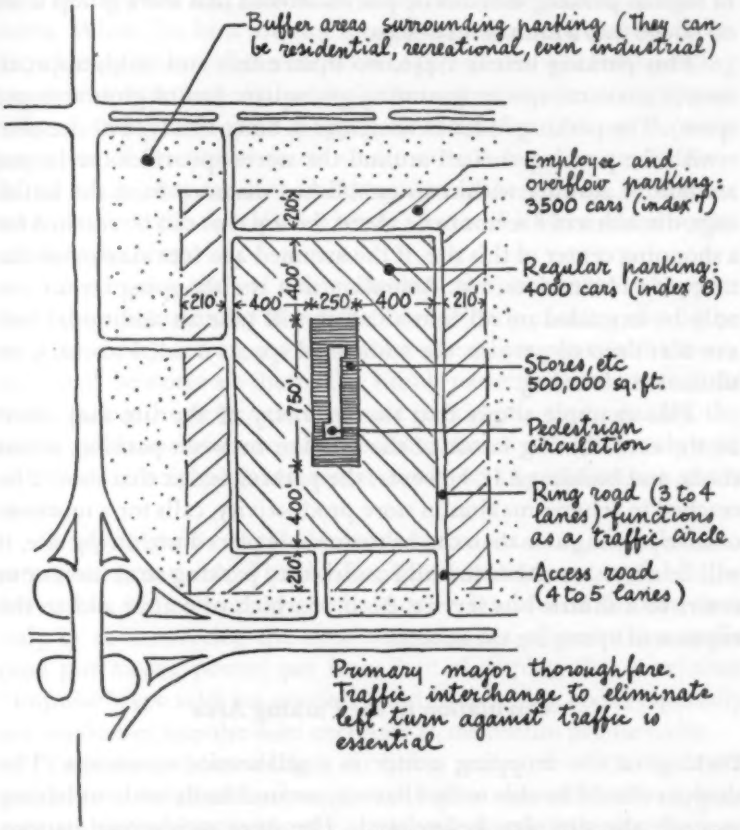
Buffer areas surrounding parking (They can be residential, recreational, even industrial)
Employee and overflow parking: 3500 cars (index 1)
Regular parking: 4000 cars (index 8)
Stores, etc 500,000 sq. ft.
Pedestrian circulation
Ring road (3 to 4 lanes) functions as a traffic circle
Access road (4 to 5 lanes)
Primary major thoroughfare. Traffic interchange to eliminate left turn against traffic is essential
210'
400'
250'
750'

FIGURE 1. The geometry of the site is a limiting factor of the development of the parking area.

walk) as the maximum distance for the overflow parking—a distance that may have to be walked only on rare occasions. As an example, take the shopping center mentioned earlier and translate it into a diagramatic plan with the stores assumed to be grouped around a landscaped mall. The average number of floors for the stores is

three (including partial basements and upper stories). The gross store area is 500,000 square feet. All around the store building there will be a parking belt 400 feet deep. This is the maximum amount of regular parking that can be placed around that store group if we do not go into a multilevel design.

This parking belt is 1,440,000 square feet and holds approximately 4,000 car spaces (counting 360 square feet of gross area per space). The parking index is, therefore 8. Since this type of site plan —with the parking area all around the stores—provides the largest amount of parking within an established distance from the buildings, the index of 8 seems to be about the top that can be reached for a shopping center of this size, if the assumed 400 feet maximum distance is to be maintained. Assuming that the shopping center can only be extended on all four sides, it will take an additional belt 210 feet deep to provide the additional spaces needed to reach an ultimate index of 15.

This example shows that the geometry of the site may often be the contributing factor of the relation between parking, access roads, and buildings. If, however, the parking index that should be reached to achieve maximum store productivity, calls for a more extensive parking area than can be reasonably placed within the site, it will be necessary either to build multi-story parking structures or to resort to a shuttle-bus service, both of which of course add to the expense of operating the center.

Circulation in the Parking Area

Parking in the shopping center is a self-service operation. The shopper should be able to find her way around easily without having to study the site plan beforehand. The most satisfactory pattern consists of parallel parking bins perpendicular to the stores with a major feeder road or ring road at the end of the bins away from the stores. This road should provide continuous circulation on the site —to act as a traffic circle. Access to the stores by vehicles should be limited to circulation to arcade and key store entrances, pick-up stations, etc., for the purpose of picking up passengers.

Other circulation adjacent to stores should be discouraged in

plan. In this way minimum interference between vehicles and pedestrians is assured. A two-way circulation within the bins is desirable because it makes it impossible for the driver to go the wrong way. Demounted shoppers walk easily along the bins from cars to stores. When the bins are not longer than 400 feet, there will be surprisingly little traffic in each one of them, even when the parking area is in full activity. Raised walks between cars are generally useless and undesirable. The shoppers would rather walk on the wide pavement of the bins than on a narrow walk between car fenders; in the north, they are also an obstacle to snow removal. The space used for the walks would do a better service if it were added to the width of the bins.

After having walked along the bin, the demounted shoppers cross the road running along the stores (curb parking should be avoided there) and are ready to enter the stores; that is, if the entrances of the stores are there. The simple pattern of stores with their fronts facing the parking area (front parking) is, undoubtedly, the best for directness of access to the stores, but is obviously only suitable for the neighborhood center made up of convenience goods stores.

Shopping-goods stores demand maximum ease of pedestrian access between stores. That is what has made them successful in the heretofore only shopping goods center— the central district. It is only by concentrating the maximum amount of pedestrian traffic (and purchasing power) per front foot of display, that maximum "impulse" type sales are possible. And in shopping goods especially are maximum impulse sales necessary to maximum productivity.

Technics and new designs are being perfected which eliminate much of the awkwardness in approaching the stores from the parking area and being exposed to the service entrances, assuming the economics of a given center require that they be at grade level.

There are, basically, two ways to solve this problem: the first is to lead the shoppers to arcades that pierce through the store building. These arcades have to be frequent enough so that the customers are not forced into an extended walk along the service yards of the stores—shielded as they may be by planting or fences—livened with directional signs and advertisements. The arcades on the other hand,

should not be too frequent because, while they provide access to smaller, shallower shops and services, they do constitute a structure which is not productive as such and hence affect the economic

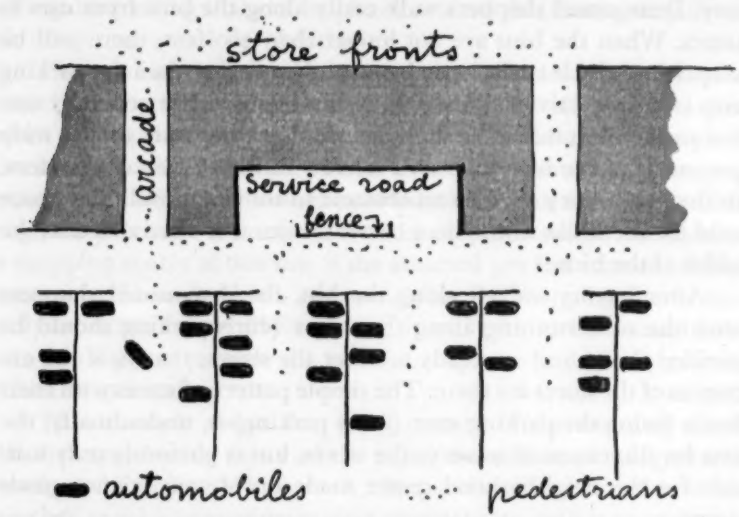

FIGURE 2. When store fronts are on the opposite side of the parking area shoppers walking from car to stores have to go through a circuitous route. . .

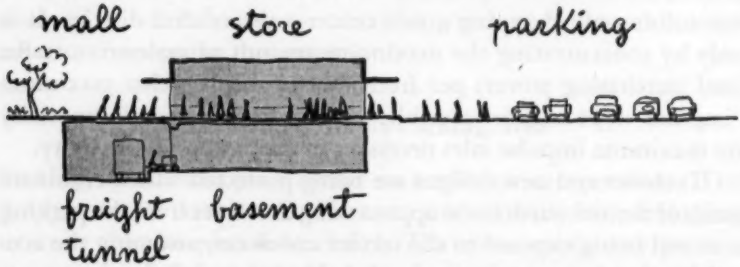

FIGURE 3. . . . unless a freight tunnel at basement level makes store fronts possible on both sides of the building.

picture. If they are too far apart, they obviously increase walking distances from parked car to store. (Fig. 2)

The second way, more costly, but under certain conditions justified—to provide an underground or below parking level servicing

passage, to reach the great majority of stores at basement level. This permits a greater number of stores to be reached directly from the parking area. Care must be used, however, not to detract too much from a concentration of common pedestrian traffic on the interior

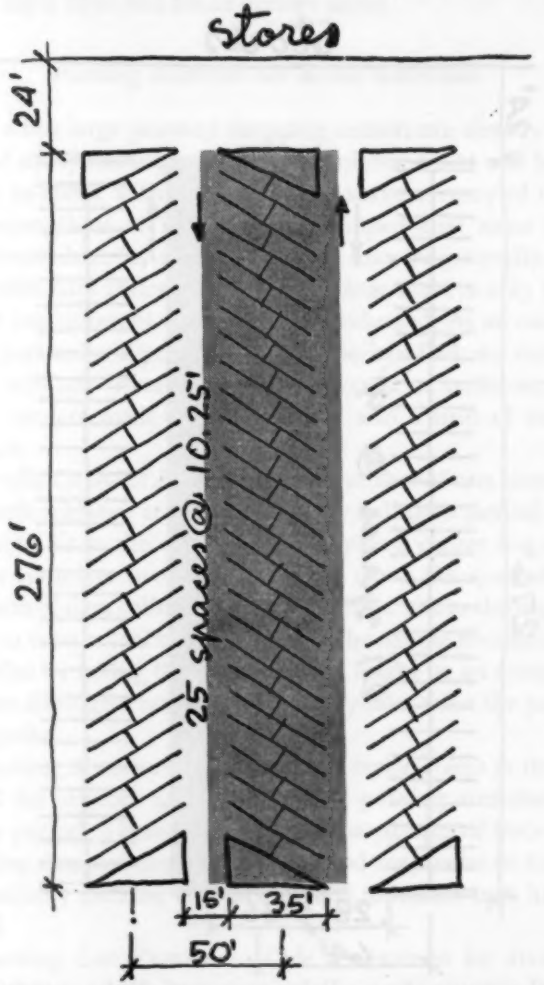

FIGURE 4. 60° one-way circulation. Gross area per car space: 276 sq. ft. (computed within shaded area).

common area, nor to complicate the operation of some kinds of stores wherein a two-front entrance can be detrimental. This system, with a greater number of stores that can use two fronts, makes it possible to reduce the number of entrance arcades.

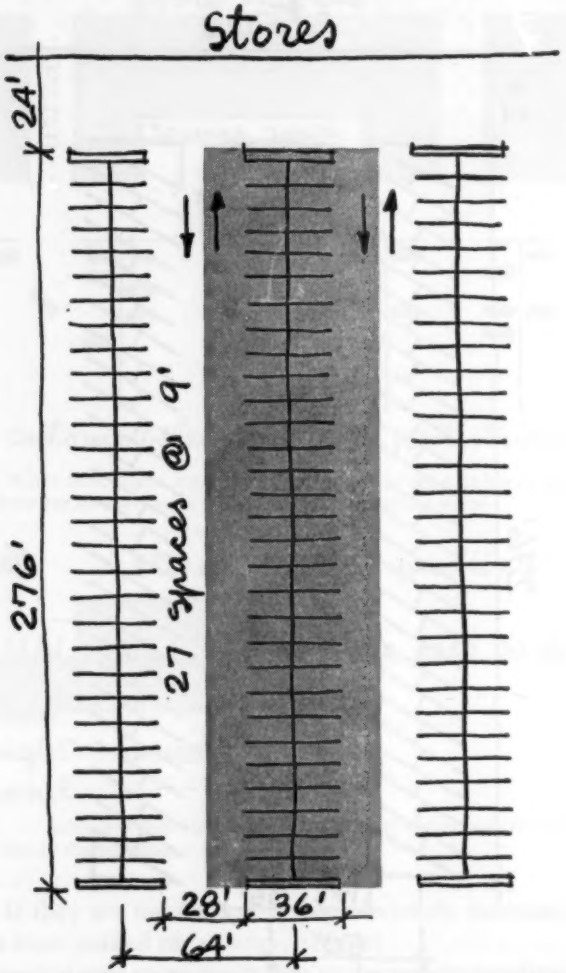

FIGURE 5. 90° two-way circulation. Gross area per car space: 295 sq. ft. (computed within shaded area).

The accompanying diagrams illustrate why the authors are generally in favor of the 90-degree pattern, because this combines economy of space with extra wide bins suitable for two-way circulation, elimination of expensive curbs (easier snow removal, too), improved sight lines and hence greater safety.

Parking Analyses for Better Forecasts

Now that a few large planned shopping centers are already in operation—and many more are expected to follow—there will be an opportunity to check with actual parking surveys many of the theoretical assumptions of the past. It is hoped that some form of standard procedure for parking analyses may be generally adopted so that traffic data collected in independent surveys may be easily compared and different trends may be evaluated. As an example of how this particular type of survey can be handled, we outline the principal subjects investigated in the course of traffic surveys for shopping centers made by an architect and a firm of real estate consultants.

1. *Traffic Count at Entrances.* The number of cars entering and leaving each entrance is plotted for every half-hour period during a whole week. Since the activity of a shopping center has a weekly cycle, any complete investigation has to cover the span of a week. Comparison of data collected during different weeks throughout the year will in turn reveal the character of the season fluctuations. It is possible also by taking the count at what might be an average time, to estimate through a comparison of daily sales what the peak times might require.

2. *Parking Accumulation.* From the traffic count at the gates is deducted the number of cars within the parking area during each half-hour period. These figures reveal the pattern of fluctuation of the parking demand during the week and may assist in forecasting when auxiliary parking or other special measures may have to be provided.

3. *Parking Lot Turnover.* This is obtained by dividing the number of cars which have entered the parking area during the whole day by the maximum number of stalls used during that day.

Turnover and accumulation are an index of the shopping habits of the region. In a shopping center which has both convenience and shopping goods, there may be periods of greater turnover due to intensive short-time convenience shopping and periods of great accumulation but less turnover when shopping is mostly for shopping goods.

4. *Duration of Parking.* Separate counts are taken in different areas of the parking lot to determine the relationship between duration of parking and the character of the adjacent stores. It is possible also at specific seasons to make an aerial photographic record of the use of the parking area as related to the generators. This can be tied in with the traffic count.

5. *Automobile Occupancy (in men, women, and children).* This will give a better knowledge of the shopping habits of the region. The persons per car are definitely greater in a suburban center, appealing to the whole family; on open nights the occupancy will certainly exceed two.

A larger automobile occupancy is generally connected with a lower sales volume per person since many of the purchases, particularly food and furnishings, are made for the family as a unit irrespective of how many persons actually participate in the shopping tour.

The Theory of Traffic Control

THEODORE CAPLOW

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IT IS now more than forty years since the first statistical studies of motor vehicle traffic were made. In almost any field of investigation, the development of reliable numerical data describing what takes place usually leads to the development of scientific principles that enable us to predict and control those same events. While there has been a great deal of accurate and ingenious research in the field of traffic control,[1] the principles developed so far stand separately; there has been no single scientific framework within which the results of different studies could be fitted together. This article is an attempt to outline in a rough and preliminary fashion the kind of general theory which might be applied to traffic control. We cannot at this stage supply the theory itself, but it is possible to indicate what some of its principal terms should be.

Many attempts to explain the movement of traffic ignore the human element, and treat traffic as something very much like hydraulics. Some go to the other extreme and interpret traffic movement in terms of the individual actions of drivers. Those who think of traffic in the first way—as a liquid moving through connecting channels—are likely to see the whole problem as a need for more expressways and grade elevations. Those who visualize traffic as a series of decisions by individuals tend to emphasize the value of driver-education in the high schools, and of New Year's resolutions.

1 Many of the research reports will be found in the bulletins and proceedings of the Highway Research Board (See Highway Research Board, Index to Publications, 1921–1949, National Research Council, Washington, 1950.) Another important group of studies will be found in the annual proceedings of the Institute of Traffic Engineers, and in the five earlier volumes of this journal.

Both of these approaches are obviously useful, but they have not been capable so far of evolving any thoroughgoing solutions. Despite tremendous expenditures and increasingly elaborate control systems, the travel time between two given points in the typical community continues to increase year by year. It is a reasonable assumption that our present technology of traffic control is unscientific, and that an adequate technology cannot be developed until it can be grounded on an adequate body of theory.

Traffic Control Defined

As a first step, we might define traffic control as the *administrative control* of a network of *traffic streams*,[2] and the rest of this paper will analyze these two key terms.

Administrative control is regarded by sociologists as a rather special form of social control in which the emphasis is upon the uniform application of procedures. It is clearly distinct from authoritarian control—illustrated by the authority of an officer over his men, or of parents over their children—and from moral control, which applies to such clearly prohibited acts as murder, stealing, and rape. These acts are restrained not only by punitive laws but also by the complex process of childhood indoctrination which leads to attitudes of conscience and guilt.

Administrative control occurs very frequently in the modern

[2] For the best measurement of the *traffic stream*, see Bruce D. Greenshields, *"Space-time Relationships of Traffic in Urban Areas,"* ITE, 1946; and *"Application of Statistical Sampling Methods to Traffic Performance at Urban Intersections,"* HRB, 1947. Among the best of the experimental or quasi-experimental studies are: M. Earl Campbell, *"Toll Bridge Influence on Highway Traffic Operation,"* HRB, 1946; M. Mansfield Todd, *"Effects of Reversible Lane Movement Signalization on Three-lane Highways,"* HRB, 1950; Richard G. Fencl, *"Jackson Boulevard: Analysis of Traffic Conditions,"* HRB, 1950; T. T. Wiley, *"Improving Manhattan's East Side Traffic"* TQ, January, 1952. The non-experimental construction of traffic formulae is illustrated by David M. Baldwin, *"Improved Measures of Accident Exposure,"* ITE, 1944; O. K. Norman, *"The Capacity of a Traffic Lane,"* ITE, 1946; R. M. Brown, *"Expressway Route Selection and Vehicular Usage,"* HRB, 1948. One of the most comprehensive attempts to generalize about traffic control was the early work of W. P. Eno, *"Simplification of Highway Traffic"*, Eno Foundation, 1929. Among the few systematic attempts to discuss the traffic stream in terms of human behavior are Theodore M. Matson, *"New Thoughts in Intersection Design,"* ITE, 1940 and A. J. Leahey, *"Observations on the Problem of Traffic Control,"* Journal of Criminal Law, 1947.

world. It is usual for such public functions as tax-collection, price-control, marriage, birth, and death registration, voting, school attendance, etc., as well as for the enforcement of factory rules, the organization of passengers and customers, the regulation of consumer credit, and the handling of crowds and audiences.

All forms of social control are of course intended to encourage certain acts, and to discourage certain other acts, but this is accomplished in quite different ways. Thus, in authoritarian situations, violation of the rules is treated as a direct challenge to the authority itself, and a distinction is always made between willful and nonwillful acts. Moral control, on the other hand, is largely self-enforced since the vast majority of the population are restrained by their own feelings from committing anti-social acts.

Many suggestions for improving the regulation of traffic amount to proposals for placing it under authoritarian control or moral control. An example of the first would be, "The police officer should have the right to fine a speeding motorist on the spot." The second would be illustrated by "Careless driving which results in someone's death should be prosecuted as murder." Suggestions like these may be emotionally satisfying: they are hardly intended to be useful. Administrative control is applied in traffic control and similar situations because it is the only type of control that will work in the circumstances.

New Approaches to Traffic Study

The general characteristics of administrative control have often been analyzed with reference to other situations than traffic, and even a simple review of them here may indicate certain new approaches to the study of traffic.

First of all, administrative control of mass behavior is partial control. It is one of the constant features of administrative control that something less—usually a good deal less—than enforcement is expected. Price-control experts at one time estimated that 60 per cent compliance on the retail level was adequate for continued operation of a price-control system, and that the maximum possible compliance under normal conditions was about 85 per cent. In the

case of tax administration, even the courts distinguish carefully among tax evasion, tax avoidance, and tax escape.

It appears that in all situations involving administrative control, the cost of enforcement rises geometrically as we approach 100 per cent compliance. While only a very slight effort is required to deter most of the potential violators in a controlled population, a really major effort is necessary to account for the serious and deliberate violations which eventually remain. In the case of traffic, it is entirely possible that 90 per cent enforcement would cost ten times as much in a given city as 80 per cent enforcement.

As a matter of actual practice, a balance is usually struck somewhere between the minimum enforcement necessary to keep the program from collapsing, and the maximum enforcement possible if cost were not considered. It should never be forgotten, however, that 100 per cent compliance with administrative control is usually impossible, and may not even be especially desirable. Thus, adequate enforcement of a 30-mile speed limit ordinarily implies that a certain proportion of vehicles will be traveling at speeds up to 35 or 40.

The other major principle of administrative control is that penalties are unevenly applied. This follows logically enough from the fact that total enforcement is ordinarily impracticable, and that comparatively few evasions out of the total of all evasions will be penalized. To put it more simply, there is ordinarily no way for administrative control to be *justly* administered, except in the negative sense that the innocent are not punished. It is certain that not all the guilty will be punished, and that equal offenses will not draw equal punishments. The exact impact of the penalties will be determined by chance, and for this reason the amount of deliberate evasion is normally high even in a law-abiding population. By the same token, the deterrent effect of punishment will be somewhat limited.

The standards which must be applied to a system of administrative control are therefore quite different from those which could be used to evaluate a criminal code or a moral obligation.

Since penalties appear to the individual as misfortune rather than as direct consequence of his acts, they should never be severe

for minor and universal offenses. The effect of excessively severe penalties is to create an active opposition to the control system, and decrease the routine compliance by which it is sustained. On the other hand, penalties that are too light may not have any real effect at all.

To have the maximum deterrent effect, penalties should really be distributed by chance. As soon as enforcement is concentrated in certain areas or on certain types of violation, the risk of apprehension in other areas or for other offenses diminishes to the point where no real control is operative.

The most important and difficult criterion to be met by a system of administrative control is that both the risk and severity of the penalty must increase with the severity of the offense. This is essential because, while partial enforcement is entirely satisfactory for the vast range of minor infractions, certain types of extreme violations carry an active and immediate threat to the whole control system.

Other Principles of Administrative Control

There are a number of other characteristics of traffic regulation that may be derived from the basic definition of administrative control.

We have already noted that something like the Law of Diminishing Returns operates in administrative control. Beyond some given point, the cost of additional conformity increases with each added unit of conformity. It may be demonstrably more expensive to increase conformity from 80 to 85 per cent than from 75 to 80 per cent. However, as in other quasi-economic situations, the reverse relationship holds true in the lower ranges. Up to a point, each added unit of control (which might be a patrolman, a stoplight, a limit sign or a parking meter) brings a greater proportionate increase in conformity.

In the case of traffic, the control situation is complicated by the fact that traffic controls are usually imposed in sequence rather than instantaneously. It ought to be possible to determine by theory, in advance of empirical confirmation, the probable effect of manipulating these sequences. What, for example, might be the expected effect of doubling the number of traffic signals on a given stretch of

road? So far as can be determined by analogous situations in other fields, the effect of increasing the number of controls is to decrease the infractions per control. Whether infractions for the entire route are increased or decreased depends on the independence of the controls. Where each control is a separate situation—as with independent signal lights—the net infraction for the route appears to increase. Where the effect of the control is cumulative, as with Speed Limit and Warning notices, the net infraction can be decreased almost to nothing by increasing the number of controls.

Driver Reaction Toward Control

So far, we have ignored those aspects of administrative control which reflect the driver's reaction as a member of a social aggregate.

The most important single finding of modern criminological research has been that most anti-social behavior is socially motivated. In the case of any juvenile delinquent who is not mentally ill, we can be fairly sure that the commission of delinquent acts was undertaken in response to the standards and demands of the group to which he belongs, even though these vary widely from those of society in general. Whenever any activity of any kind is widespread, we can be reasonably certain that it commands approval at some point where approval matters.

The most casual scrutiny of driving habits and patterns will disclose that there are several kinds of behavior which command approval in our society, and are sources of self-satisfaction for individuals.

Consistent or total conformity is one of the most satisfying patterns of response to a situation involving administrative control. It is a more frequent pattern than we usually suppose. One has only to think of the number of employes who retire from a lifetime of industrial service with the incredible feat of no absences and no lateness—ever. Although the arrangement of the traffic control system tends to keep the number of total conformers to a minimum, they form a considerable fraction of the total. Drivers of this type scrupulously avoid infractions, and often take pride in never having been tagged for so much as overtime parking. The conforming

driver probably prides himself on *never* going 41 in a 40-mile zone; on always stopping fully ten feet behind an open streetcar; on never crossing a yellow line, and on always coming to a full stop at Stop signs. By this behavior, he protects himself against being in the wrong in an accident, he asserts his moral superiority over less consistent drivers, he hears himself described in such favorable terms as "safe and steady," and he also gains the right to release his aggressions in a socially approved fashion by criticizing less consistent drivers.

Selective non-conformity is also satisfying. In a very real sense, the automobile is the great American plaything, and we have transferred to it many of the attitudes and values that have to do with games. Regarded in this fashion, driving is above all else a demonstration of skill and boldness, and the highway is an ideal ground for self-assertion. There is really not much point in arguing that it shouldn't be. To change our basic attitudes toward the automobile would take a far more drastic revision of our national psychology than is ever likely to be achieved by driver-education. Almost no American male will admit to being a poor driver, and it can be a deadly insult to imply that a man's parking is below par.

As a practical matter, skill and boldness in driving are demonstrated by: driving faster than others along the same route; evading regulations without getting caught; passing, parking, and turning with especially narrow clearances, and winning contests for the right-of-way.

All of these activities appear to be dangerous although under favorable conditions they may actually decrease the accident risk by increasing the driver's alertness.

We simply do not know enough about selective non-conformity, extreme non-conformity, nor the passive response to traffic regulation to estimate their effects in detail. There is every reason to think, however, that it is in terms of typologies of this kind, rather than sex, occupation, or reaction time, that we will eventually be able to distinguish the hazardous from the safe drivers.

Moreover, it is only in terms of *types of driving* that we will eventually be able to assess the effect of various kinds of reinforcements and deterrents that occur along the route itself.

For example, it appears that an increase in the rate of infraction in a traffic stream occurs whenever a factor of delay appears. Drivers will tend to speed up and to cut corners whenever a trip begins to take longer than they had anticipated, and an extreme deviation from expected travel time (like being caught behind a slow truck on a ten-mile grade) will induce almost all drivers to violate the regulations. The greatest need at the moment would seem to be the correlation of both control devices and traffic situations with the types of behavior observed in drivers.

The most promising research approach is the study of driver-behavior from inside the vehicle, and over a fairly long period of time. Such case studies would need to be supplemented by test information on vision, coordination, and reaction time, and perhaps by the kind of speed-and-time-record now kept automatically on some long-distance trucks. The basic problem, however, is to determine empirically what the basic patterns of driver-behavior are, how they are influenced by various kinds of traffic conditions, and how they are related to personal and social background factors.

Four Elements of the Traffic Stream

The second key element in our definition was the *traffic stream*, which may be simply defined as the aggregate of vehicles moving between two given points on a single route during a given interval of time.

This is apparently the only unit that promises to be indispensable in the systematic analysis of traffic behavior. Study of the individual driver tells us a great deal about him, but very little about the relationship of a roadway and the whole volume of traffic it bears. Studies of gross volumes ignore or underestimate the differences existing between vehicular streams of the same volume.

The classification of traffic streams is an exceedingly complicated matter. At least four elements of motion should form part of the description of any traffic stream whatever under any circumstances. These are volume, velocity, spacing, and continuity.

In general, the intersectional control of traffic streams which differ in any of these four characteristics will be more difficult and

the intersections themselves will be more hazardous than with traffic streams which resemble each other in these respects.

Further classification of traffic streams in terms of vehicle types, driver characteristics, uniformity of total routes, and driver expectations, leads us into almost blank territory, full of statistical obstacles. It is apparent that sooner or later these will have to be surmounted, but in the meantime a useful start can be made from another direction.

The application of any traffic measurement necessarily takes place within a traffic pattern. In urban areas in the United States, the traffic pattern is tightly centralized so that almost all major traffic streams converge in the morning on a tiny downtown area, and disperse in the evening from the same congested center.

During the intervening hours, there tends to be a balance of traffic in both directions, but the whole pattern can still be understood only by reference to its dominant center.

Communities Divided into Zones

The typical American community is divided into several roughly concentric zones, in each of which different traffic conditions obtain. The central business district is—with few exceptions—limited to an average diameter of a mile or less so that most points within it lie at convenient walking distance from each other. In most cities, its streets form a gridiron, based on rectangular blocks and frequent intersections, on which the density of traffic remains extremely high throughout the working day and into the early evening hours.

The surrounding zone is one of warehouses, factories, depots, slums, rooming-house districts, small parks, apartment houses, hobo areas, public markets, parking lots, stores, railroad yards, and a vast jumble of necessary urban functions. Because most of the goods entering and leaving a city are directed through this zone, its streets tend to be crowded by parked and moving trucks. Because it has a numerous and somewhat disorganized population, its streets are the most hazardous for pedestrians. Since it usually shows more deterioration and less planning than other urban districts, its streets tend to be badly designed, and badly maintained.

The next zone may be characterized as lower-income residential. Since it was built up before the advent of zoning, it also includes a considerable mixture of commercial, industrial, and service facilities. More than half of the population of most cities is found in this area whose outer boundaries are roughly coterminous with the transit network which existed about 1910. In cities which then depended primarily on street railways, the cross-town streetcar routes most distant from the central business district usually mark these limits. Such districts usually have a sufficient number of wide axial streets, but with very numerous crossing traffic streams and considerable pedestrian movement. With the great post-war increase of intra-urban traffic, the former side streets of this zone have become alternate routes of importance.

The fourth zone in most cities was created during the building boom of the 1920s. It tends normally to be an area of owner-occupied one-family houses, built under strict zoning, with non-residential establishments confined to spaced intersections. The street plan is likely to be more rigorously rectangular than in any other part of the city. There is usually specific provision for a number of evenly located main traffic arteries, but these are normally bordered with good housing. Boulevards and parkways are often part of the plan. Truck traffic is often segregated.

The outermost or suburban circle is typically larger than all of the others combined, and its boundaries are not well-defined. Included in the suburban fringe are a great many new residential developments, districts of private estates, semi-rural villages and farms, heavy industrial developments, golf courses, cemeteries, nursery gardens, and a variety of other functions which require space. The population growth of these areas has been rapid and violent in recent years, and promises to continue for a long time. Most suburban areas have access to one or the other of the major cross-country highways which serve a large city, but many of these are sadly overburdened by the recent increase in suburban traffic.

It is only a slight over-simplification to say that each of these zones has a characteristic traffic-control problem based upon the nature of its street plan and its traffic streams.

Traffic Patterns in Each Zone

In the central business district, the primary problem is the parking and unparking of vehicles, and the failure to provide adequate disposal of vehicles is reflected by traffic slowed down to less than a walking pace.

In the second zone, control is relatively simple except during the peak hours when jams multiplying each other by chain action form a kind of barrier which is costly, time-consuming, and discouraging to the tens of thousands of people involved every day.

In the third zone, adequate traffic direction revolves around questions of signalization and intersection control.

The fourth zone has in some ways the most severe traffic problems of all, although they have seldom been clearly recognized. When these well-planned residential areas were constructed, they stood on the outskirts of town and provided the amenities of quiet and open space now advertised by the new suburbs. The side streets were not intended to take any through-traffic, and the main streets were usually built wide and smooth to avoid the blighting effect of excessive traffic movement.

With the building up of the suburban areas, these safeguards have proved inadequate. In the desperate search for alternate routes, many side streets have been pressed into service with a consequent decline in safety, quiet, and other neighborhood values. A vicious cycle is involved here. The growth of the suburbs in the last few years is responsible for the traffic pressure that is destroying the character of these older "good" districts. One effect is to encourage further migration to the suburbs, which in turn increases the amount of filtering traffic, which in turn encourages the flight of the present residents, and so forth.

In the suburbs, traffic control involves the direction of fast-moving traffic streams based on overburdened main highways. Considerations of safety and speed are closely related. In practice, both have had to be sacrificed as the gap between the actual and the theoretical traffic capacity of these suburban highway networks narrows or disappears.

Each city, of course, has a pattern that is somewhat its own, but these five typical situations will be found somewhere in every American community with a population of 100,000 or more.

It can not be stressed too strongly that the character of the traffic stream really changes from zone to zone. Only by taking these changes into account is adequate traffic control possible.

Thus, for example, a rational policy in the fourth zone is to give the main traffic streets every conceivable advantage by signalization and direction over the side streets. The reverse is true in the third zone where there is every reason to seek full street utilization throughout the gridiron.

Or to take a somewhat different instance: where interior expressways are needed at all, they will certainly be most needed for the crossing of the second zone. If this interior section is missing, the net effect of a long expressway may be to increase average travel time.

In the same way, a fairly good argument can be made against uniform speed limits applied throughout a city. One immediate result is to encourage infraction in the outer zones; another is to encourage excessive speed and create jams in the central business district.

Criteria for Suburban Routes

The longer-range questions of highway planning yield to the same sort of analysis. The principal criterion for suburban routes ought to be the avoidance of blight and traffic interference in older residential areas. By this standard, a straight line is not often the best distance between two points. Another element of complexity in the design of suburban routes is the fact that new routes have at present an immediately stimulating effect on the pattern of settlement. An origin-and-destination study may show us what the traffic would be on a projected route if it were there now, but it can not show what the traffic will actually be by the time construction is completed.

The provision of cross-town routes also assumes more importance as the suburbs grow and exert their general decentralizing influence. The largest volume of cross-town traffic will almost invariably be found between the third and the fourth zone. Since

public transit is usually established there, and since such a route must cross all of the major radial streets approaching the central district, the arrangement presents peculiar difficulties. Yet if they are not met, as they usually are not, the improvisation of alternate cross-town routes close to the same line is remarkably productive of hazard, traffic interference, and residential blight.

One further example may serve to illustrate the potential usefulness of a theory grounded on the systematic consideration of traffic streams. The two great diurnal movements of traffic to and from the urban center are different in many ways. The effectiveness of traffic control in the morning depends largely upon the speed and ease with which vehicles arriving at their central destinations can be removed from the stream. Since halts in the stream have a multiplier effect, keeping central traffic moving may require devices to delay approaching traffic long before it reaches the central district.

In the evening, the conditions are very nearly reversed, the principal requirement being the acceleration of traffic streams moving through the second zone and part of the third, together with the reduction of crosstown interference. Since we generally apply the same system of traffic control to morning and evening traffic, it is easy to see why it works awkardly in both situations: causing an excessive decrease of velocity in the morning traffic stream, and an irregular and unpredictable series of jams in the evening.

Skilled traffic officers have long understood most of the principles discussed here in an intutitive fashion and applied them—principally through the practice of keeping traffic moving, even at very low speed, wherever high volume is concentrated. In the same way, they have often correctly estimated the hazards offered by intersections containing incongruous traffic streams.

It seems certain, on the other hand, that the possibilities of enlightened traffic control in urban areas have hardly been approached. The key to getting the maximum usefulness out of our over-burdened streets seems to lie in a more careful study of the influence of the central traffic tangle upon outlying traffic streams, and a much more intensive classification of traffic streams than most surveys have ever contemplated.

Parkington: Shopping Center Design

R. H. TATLOW III

Mr. Tatlow is president of Abbott, Merkt and Co., architect-engineer firm of New York City. After two years with the United States Bureau of Public Roads on cost studies and highway engineering, Mr. Tatlow joined the staff of and later became a member of a firm of consulting engineers. He resigned from this partnership when war preparations started in order to help organize the architectural and engineering design branch of the Army's Construction Division. He became one of the five members of the War Department's Construction Advisory Board. At the war's end, he became president of his present firm as well as one of its directors. Mr. Tatlow has written many technical articles. He is a member of the American Institute of Consulting Engineers, American Society of Civil Engineers and American Society of Mechanical Engineers.

SUBURBAN shopping centers and suburban department stores have mushroomed so fast around the United States during the last ten years they no longer are news. This discussion concerns the largest suburban store built to date—the first shopping center to be built around a multi-story parking garage, the largest parking garage in the United States today.

This unique project is the Hecht Company's "Parkington" in Arlington, Virginia, opened on November 2, 1951. It is already one of the outstanding suburban store successes of the country from a volume point of view. When the other thirty satellite stores are complete sometime in 1952, the development will become one of the outstanding shopping centers in America.

Store executives are faced with the fact that branch stores definitely have appeal, and that sooner or later they must come to grips with a branch store project of their own. Perhaps a discussion of the experiences of one store in the development of an outlying shopping center—Parkington, Virginia—will add something worth while to the expanding knowledge in this field.

Suburban shopping centers spearheaded by major department

stores are destined to change the buying habits of city and near-city folks. The Hecht Company's management recognized this trend early and started planning expansion before World War II. At the war's close The Hecht Company built their Silver Spring, Maryland, store of 160,000 square feet, and almost immediately enlarged it to 200,000 square feet on the fringe of an established shopping area. There the store was placed on 100 per cent of their property, and parking was developed around it by the county. Promptly others built satellite stores.

A Virginia store was part of the original planning and with completion of the Silver Spring unit, serious thought was given to Virginia.

Initial consideration centered on economic studies and the availability of land. An executive of The Hecht Company made these studies with the help of chambers of commerce, county and utility organizations, and others. He ferreted out facts on all contributing items such as population distribution, character, income and growth, building permits, retail expenditures classified by population groups, annual retail sales of Arlington County by various store groups, highway plans, zoning, driving-times and distances and other related factors. As a result of the studies, it was agreed that the most satisfactory site would be in or around Clarendon, in Arlington County, Virginia.

Immediately local real estate firms were asked to develop available property, and they found a wide variety. Clarendon was growing fast and small compact sites on or adjacent to the "main street" were considered along with large acreage ten or more miles in the hinterland.

In early 1950 site selection was narrowed and extensive discussions developed ground rules to be followed.

Basic Requirements

Store management realized that The Hecht Company store would be the spark for a surrounding retail growth. They knew that success for themselves required good, strong, successful neighbors well

located and with next-door parking. Participation in a project developed by others could never give them control over the character of occupancy of the shopping center or of its parking facilities. Financially, they saw an opportunity to participate in all of the success of their efforts in return for some additional planning time of their executives.

Accordingly the following basic requirements were established as fundamental to the choice of a site; they would—

a. Develop a complete one-stop shopping center with adequate parking.

b. Build a complete department store of not less than 200,000 square feet.

c. Plan about 25 other stores, the potential list including as most important a drug store, supermarket, 5 and 10, junior department store, furniture store, men's and women's specialty shops, shoe stores, service operations, florist and restaurant.

Opinions on "adequate" parking vary as widely as the number of those expressing them. Years ago, Abbott, Merkt and Company, architect-engineers, made studies of parking needs based upon dollar sales, and that same approach to the problem can be made today. One might start with the average sale, which varies from $4.50 to $6.50 (or more), and apply factors for such things as customers arriving by car, persons per car, turnover of parking space, area per car, and occupancy of parking lot. This gives the feeling of a scientific approach to one of the great unknowns of shopping, but it merely represents the assembly of a variety of assumptions. The use of area relationships seems at this time to promise equally good results.

There is little question but that a parking space of 3.5 square feet per square foot of gross building area will rarely be used to capacity. A parking ratio of 3 to 1 probably is desirable, but where street parking is possible and foot or bus traffic accounts for some of the customers, the ratio may drop to less than 2 to 1.

Assuming a 200,000 square foot department store covering

50,000 square feet of ground and giving 3 to 1 parking, the need was probably not greater than 650,000 square feet. Adding another 100,000 square feet for the neighboring stores another 400,000 square feet could be used.

The target for a site might then have been around 1,000,000 square feet or twenty-three acres. Multi-story parking would of course change the land use and permit a smaller site. Plans for many shopping centers have included theaters and office buildings and these were discussed, then omitted. A theater would interfere with parking for night openings and an office building seemed to offer very small return.

The Site

In the spring of 1950, engineering studies were made to evaluate several sites. The site purchased lies about one mile west of Clarendon at the intersection of Glebe Road and Wilson Boulevard eight miles from The Hecht Company's downtown Washington store. (See Figure I). These two important Arlington County streets form two sides of the triangular fifteen-acre site, with Randolph Street as the third. Roughly, dimensions of the property are 1,150 feet on Wilson Boulevard, 1,050 feet on Glebe Road and 710 feet on Randolph Street.

Approximately four acres of property were also bought across the streets in order to participate in the anticipated commercial growth of the area, with overflow parking for customers.

The site is situated in the center of a rapidly growing community where it is the natural shopping center for over 300,000 people. Fortunately the physical characteristics were excellent for foundations and grades. The primary problem in development of the site as a shopping center was its triangular shape and its limited area.

Parkington Described

To describe this shopping center in words is a bit difficult because of its extremely high efficiency in the use of every square foot. Parkington has 1,146,000 square feet of buildings. Incidentally that is twenty-six acres or almost twice the ground area of the site.

Parkington consists of The Hecht Company store of 300,000 square feet with its basement and four floors, against which is the parking building of about 640,000 square feet in five floors with a partial basement. On the perimeter of the site, flanking and sur-

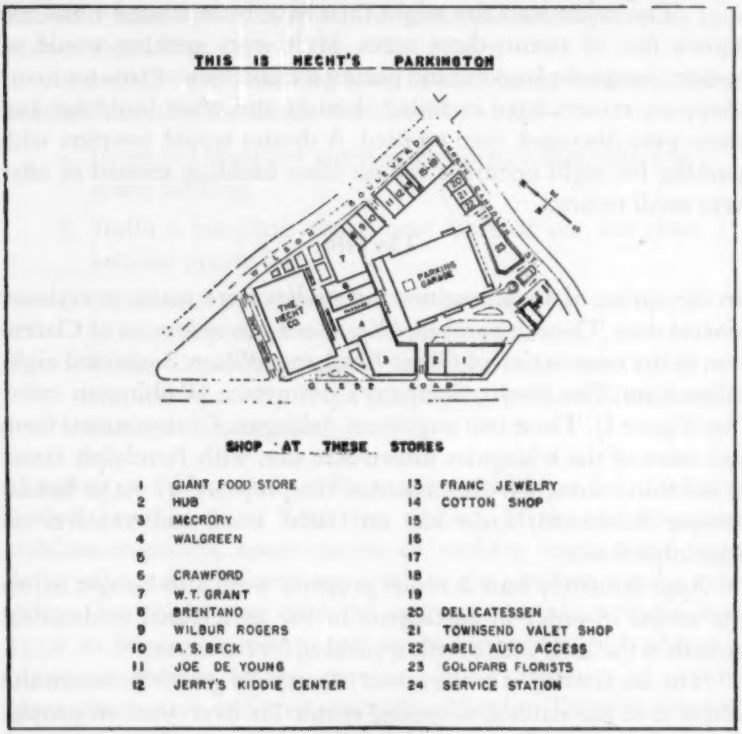


FIGURE 1.

rounding the parking, are the neighbor stores, housed in six one-story and basement buildings and in the arcade of the parking building. In addition, there is a super-service filling station on Randolph Street and there will be two buildings on the point now temporarily used for parking.

Buildings, their relation to one another, and first floor division for tenants are shown in Figure 1.

Notice that the stores all have street-front locations and are visible to all who pass. Notice also that traffic has been given every

possible consideration: eleven traffic lanes serve the parking building, four serve the point. The Hecht Company donated land to add an extra traffic lane on all sides to assure proper traffic transition. Traffic studies of volume and flow were among the first steps and both county and state highway officials cooperated in every way. Traffic flow data are shown in Figure 2—Part 2.

The character of the shopping center and its construction was determined at the start with the decision calling for simple yet distinctive modern architecture of high quality and low cost for both construction and maintenance. Utility without unnecessary embellishment was the rule.

A glazed green brick was chosen as the primary exterior material for the department store with red granux, stainless steel and redwood as other materials. Neighbor stores use similar materials supplemented by crab orchard stone, and Roman brick. The streamlined parking building with its open sides needs no other glamour than its structural material, reinforced concrete.

All neighbor stores are being built with a ground floor and complete basement. Buildings joining the parking building are designed for one future floor. Grant's now has a small second story office space to give direct entrance to the second floor parking, as does McCrory. The basements are used for both selling and service.

Figures 3 and 4 show the architectural character of the neighbor stores on Glebe Road and Wilson Boulevard. One of the most interesting of the neighbor stores will be the Hecht Company's Arcadian Gardens, a self-service flower shop with adjoining greenhouse and lattice area.

A perspective view of The Hecht Company windowless store with motorstairs from bottom to top is shown in Figure 5. This is a complete store of 147 departments with a full range of merchandise carried in reasonable depth.

Column spacing is interesting because it was carefully considered to give maximum flexibility and utility without the higher costs of longer spans. Uniform spacing 25 feet, 6 inches by 27 feet to suit interior counters fails to suit perimeter conditions; hence, to avoid presenting a row of columns to entering customers exterior spans were lengthened to thirty-two feet.

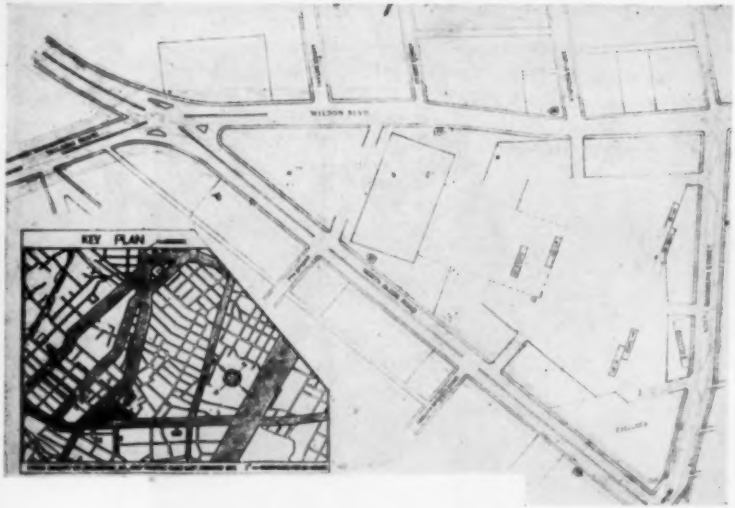
TRAFFIC COUNT BY COUNTY OF ARLINGTON, VA. MAY 22–29, 1950

Made by Tape Recorder

NOTE: 24 Hour totals taken from 9.30 a.m. to 9.00 a.m. next day.

			TRAFFIC COUNTS									ADJUSTED PEAKS						
HIGHWAY	Date	Day of Week	24 Hr. Total	Aver. Per Hr.	8½ Hr. Total 9.30 a.m. to 6.00 p.m.	8½ Hr. Aver.	Peak Hours No.	Peak Hours Period	10% of 24 Hr. Total	9½ Hr. Total 9.00 a.m. to 6.30 p.m.	Aver. per Hour	Factor	Computed 24 Hr. Total	Peak Aver. Per Hr.	6½ Hr. Total 9.00 a.m. to 6.30 p.m.	Aver. per Hour	Peak Hr.	Peak Hour 10% of 24 Hr. Total
Wilson Blvd. W. of N. Randolph St.	5/18/50	Thur.	9,235	385	4,758	562	910	5.00–6.00 p.m.	923	5,361	564	1.478	13,620	570	7,900	830	1,342	1,362
	5/19/50	Fri.	9,882	410	5,001	590	939	4.30–5.30 p.m.	988	5,570	585	1.368	13,520	564	7,600	802	1,284	1,352
	5/20/50	Sat.	10,047	420	6,357	750	820	12.00–1.00 p.m.	1,005	6,978	733	1.222	12,350	514	7,790	819	1,003	1,235
Total 3 days			29,164		16,116	1,902	2,669		2,916	17,909	1,882		39,490	1,638	23,290	2,451	3,629	3,949
Aver. of 3 days			9,721	405	5,372	630	890		972	5,969	627		13,163	546	7,763	817	1,210	1,316
	5/21/50	Sun.	8,252	343	3,919	460	527	7.00–8.00 p.m.	825	4,310	455	1.088			Not Included			
Wilson Blvd. E. of Glebe Rd.	5/22/50	Mon.	9,035	376	4,764	560	957	5.00–6.00 p.m.	904	5,285	558	1.525	12,600	525	8,070	848	1,461	1,260
N. Randolph St. S. of Wilson Blvd.	5/23/50	Tues.	3,514	146	2,105	247	317 314	12.00–1.00 p.m. 4.30–5.30 p.m.	351	2,377	251	1.608	5,640	235	3,818	401	519	564
N. Randolph St. N. of Wilson Blvd.	5/24/50	Wed.	781	33	378	45	85	5.00–6.00 p.m.	78	453	48	1.422	1,115	48	647	68	121	112
Glebe Rd. N. of Wilson Blvd.	5/22/50	Mon.	8,469	352	4,250	500	752	4.30–5.30 p.m.	847	4,760	501	1.525	12,950	540	7,270	765	1,150	1,295
Glebe Rd. Between Wilson Blvd. & N. Randolph St.	5/23/50	Tues.	8,714	363	4,206	496	660 686	4.30–5.30 p.m. 7.30–8.30 p.m.	872	4,695	494	1.608	14,050	587	7,580	802	1,120	1,405
N. Taylor St. N. of Wilson Blvd.	5/25/50	Thur.	1,165	49	564	66	137	5.00–6.00 p.m.	117	789	83	1.478	1,720	72	1,162	123	202	172
N. Stuart St. N. of Wilson Blvd.	5/25/50	Thur.	675	28	393	46	82	5.00–6.00 p.m.	68	453	48	1.478	998	42	669	71	121	100
N. Stafford St. N. of Wilson Blvd.	5/24/50	Wed.	1,344	56	673	79	140	4.00–5.00 p.m.	135	785	83	1.422	1,920	80	1,120	118	200	192

FIGURE 2—PART 2.



TRAFFIC DATA

THE HECHT CO.

ARLINGTON, VA. STORE

Hecht Parking represents Created Traffic which is additional to Existing Traffic as shown in tables. It is anticipated that facilities will be provided for parking 2,500 cars with a turnover of 2 or a total parking of 5,000 cars per 8 Hr. day. It is assumed that during the peak hour 922 cars will go in and 761 cars out.

Peak inbound 10–11 a.m. Peak outbound 4.30–5.30 p.m.

The hourly peak is distributed to street use in the same proportion as that of the marginal street traffic:

i.e.	Wilson Blvd., Glebe to Randolph	277 + 228	= 505
	Glebe Rd., Wilson to Randolph	277 + 228	= 505
	N. Randolph St., Wilson to Glebe	2 (184 + 152)	= 672
	Total		1,682

Of the above, it is assumed that traffic peaks are at one time which is extremely conservative.

Revised Traffic

	½ Adjusted Peak Traffic	*Additional Created Traffic*	*Total Cars per Peak Hour*
Wilson Blvd.	730	470	1,200
Glebe Rd.	560	360	920
N. Randolph St.	260	170	430

Basis for Determining Peak Traffic

Daily Per Cent of Aver. Week Day		*Monthly Per Cent of Aver. Month*	
Mon.	97%	Jan. 77%	July 130%
Tues.	92%	Feb. 72%	Aug. 132%
Wed.	103%	Mar. 75%	Sept. 113%
Thur.	100%	Apr. 100%	Oct. 102%
Fri.	108%	May 108%	Nov. 89%
Sat.	121%	June 124%	Dec. 78%
Sun.	136% (Not included in computation) Period covering store operations only.		

Formulation for transforming days in May to peak day in August which is peak month. Peak day in week is Saturday.

Factors to be used relative to actual traffic counts

$$\text{Mon.}\ \frac{121}{97} \times \frac{132}{108} = 1.525$$

$$\text{Tues.}\ \frac{121}{92} \times \frac{132}{108} = 1.608$$

$$\text{Wed.}\ \frac{121}{103} \times \frac{132}{108} = 1.422$$

$$\text{Thur.}\ \frac{121}{100} \times \frac{132}{108} = 1.478$$

$$\text{Fri.}\ \frac{121}{108} \times \frac{132}{108} = 1.368$$

$$\text{Sat.}\ \frac{121}{121} \times \frac{132}{108} = 1.222$$

NOTE: Bus Service* shown on map thus ⬠

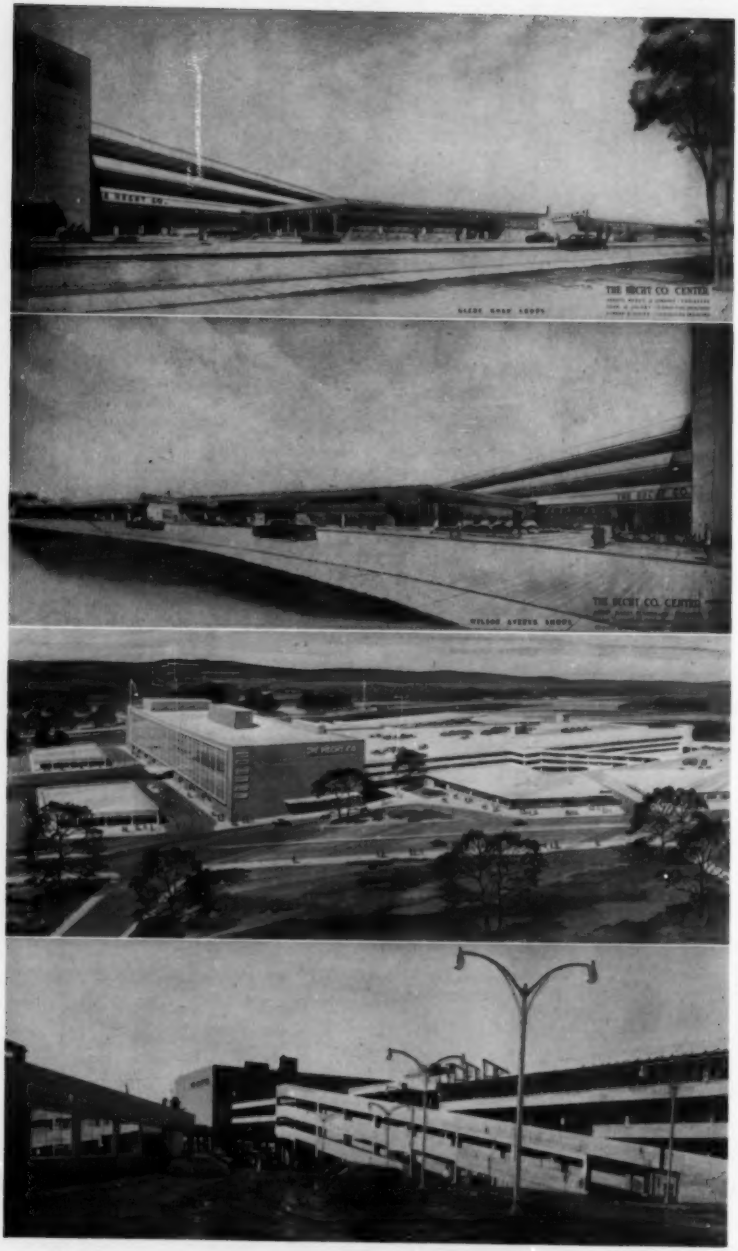
Daily (24 Hr. Service)

Glebe Rd.	N. Bound	47
	S. Bound	46
Wilson Blvd.	E. Bound . . .	90
	W. Bound . . .	86

* Figures from Mr. Odell. 5/23/50.

(°°°) Traffic lights.

FIGURE 2—PART 1.



FIGURES 3, 4, 5 AND 6. Four Views of Shopping Center.

Merchants have long had experience with "main street"; hence, street fronts are highly desired. Parkington brought a dilemma: which was the front and which was the back?

Each tenant quickly recognized that he had two important fronts.

Figure 6 shows the general architecture of the parking side of stores. It also shows yard parking and ramps on one side of the parking building.

Architectural and structural designs of the neighbor stores were fixed within reasonable limits. Tenants were free to design (subject to our approval) their own exteriors below the canopy on the street and for a 12 foot height on the parking side. Clear ceiling heights of from 13 to 14 feet were provided. Signs were limited to a three foot height.

Parking

Any shopping center starts with its parking, and Parkington is no exception. In designing this parking, we decided that we would have:

(a) Customers park their own cars. This meant easy driving and easy parking.

(b) One-way traffic.

(c) A minimum of walking. The average distance is less than 300 feet, compared with initial studies which showed an average of 585 feet to the department store.

(d) Covered walking. Actually more than 50 per cent of all parking is covered, and 110 feet would be the maximum uncovered walking required.

(e) Direct connection with the main store.

(f) Provision to pick up passengers at the Hecht Company flanking stores or central core.

(g) Quick discharge of cars. With all facilities outbound for night closing, the cars can leave in 20 minutes.

Following these essentials as a guide, the five-story parking building with each floor of about three acres is unique in this country for

its large size and ease of movement. It is immediately adjacent to the Hecht Company Store and the basement of 64,000 square feet, the first and second floors match the store levels. Other floors are made 10 feet floor to floor, so that they make use of exit stairs of the store. Height of the store's first floor was seventeen feet and, to take full advantage of the building cube, a portion of the ground floor was depressed three feet. This avoided need for costly ventilation as required for the normal basement parking.

A great variety of floor layouts and garage designs were carefully considered on the basis of construction cost and ease of use by the public. Staggered floors, internal and external straight and spiral ramps, mechanized parking with and without elevators, with and without motorized horizontal platforms, mobile elevators and gravity movements were examined. Many types of concrete and steel structures were designed and the construction contractor made cost estimates on each. Water penetration, bay sizes and parking modules were all explored. The result of these studies was adoption of the final size, shape and design.

In general the garage is 216 feet by 570 feet with column spacing 27 feet by 30 feet. It is designed in reinforced concrete as a flat slab with open spandrels and a flat floor. The entire floor is devoted to parking with the exception of one central bay, the core, which is used for public toilets, a stair and elevators. Flanking the building on both of the long sides are straight ramps with only 10 per cent grades. Cars can drive up on either side and turn off at each floor on a super-elevated turn. Thus, one of the important requirements of fast parking has been solved. Two continuous lanes of inbound cars can be easily handled. The most pressing need for a shopping garage is rapid exodus and this garage provides straight express ramps on one side directly from each floor to the ground, located one below the other. On the other side, below the up express ramps, are a series of short floor-to-floor ramps by which cars can circulate through the entire building.

Parking in the building is diagonal on 68°. Stalls are 8 feet 3 inches wide and aisles are nineteen to twenty feet wide. Three cars are parked on this diagonal between the thirty-foot columns and longitudinal 6 inch high concrete bumpers, 54 feet apart, separate

the rows of parked cars. The bumper curbs are 3 feet, 6 inches wide. Throughout the garage the policy of parking on both sides of every aisle has been followed to give maximum efficiency. Incidentally, this was accomplished by a most unusual structural design with

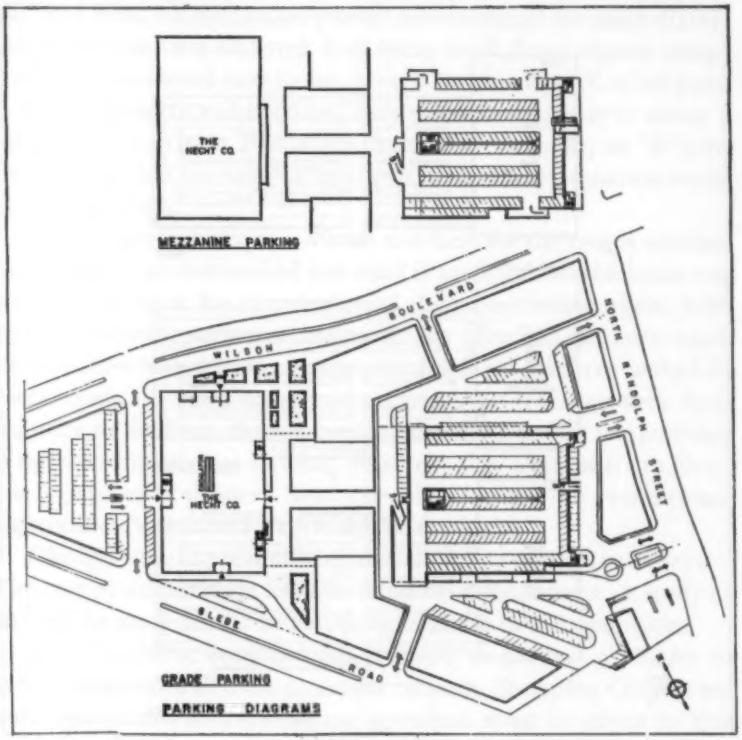


FIGURE 7.

cantilevers of one half bay on all sides. Six cars are parked in 1,620 square feet, or 270 square feet per car.

Code requirements for floor loads were thrashed out with local authorities and an 80 pound per square foot allowance obtained. One or two codes allow 60 pounds but many ask 100 to 150 pounds based upon outdated ideas. Trucks, of course, must be prohibited. This structure limits use by vertical clearance of 7 feet at a few points and 9 feet, 3 inches generally.

Roof-parking on neighbor stores was planned initially, then

abandoned. On the two buildings joining the garage, limited parking is still possible and may be used. Diagrams of the parking buildings are shown in Figures 7 and 8. Note the entrances to the Hecht Company store.

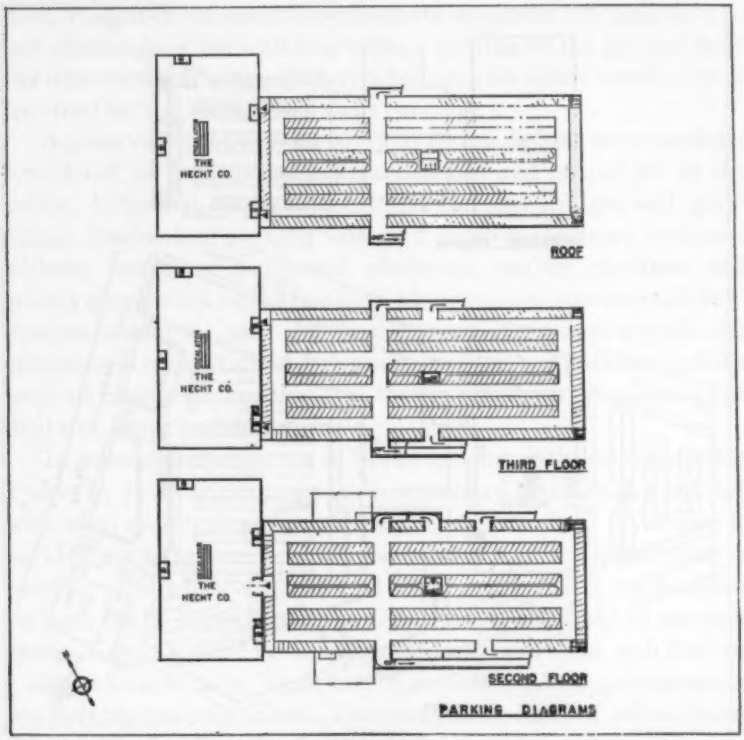


FIGURE 8.

A charge of 25 cents an hour after the first two hours has been initiated, because it is essential to prevent all-day parking. There are people who would drive in from outlying suburbs, then take a bus to their work. Turnover of parking averages 3.3 cars a day.

Vertical transportation for parkers consists of stairs at each corner and in the central core. The core has one automatic elevator and room for a second. From the ground to second floor, provision is made for motorstairs.

Consideration was given to package pick-up stations, but the

high cost of mechanical distribution and the long time cycle caused it to be dropped.

The garage has now been in operation for some months and it is working out about as planned. Several items warrant mention. One exit turn from the mezzanine proved to be difficult for some drivers and its entrance was widened. Exit turns to all down express ramps would be considered easy in any garage, but because all other parts of these ramps are so luxurious, they were troublesome to about 5 per cent of the drivers. Part of the problem is created by an "S" turn for one lane, but the trouble has been overcome by concrete curbs channeling traffic.

Winter weather was considered and heat for the ramps studied. Costs made it uneconomical and sand is used. Added thickness was provided to allow for chemicals and their destructive effect, with replaced wearing surface at intervals. No chemical has been used. Ice and snow have left an unexpected difficulty. Cars are parked in a wet condition when temperatures are above freezing; they drop moisture to the floor, then at evening the weather and temperature of the slab drops below freezing, causing a thin sheet of ice to form, just enough to be slippery. Sand stops the slipping, but causes cleaning troubles. We expect to solve this next winter.

Charges were to prevent long, non-shopping parkers and they do. The cost of collecting is, to date, more than the income. A study of this will be made when the shopping center is in full operation.

Street traffic at peak periods is going to present problems to public authorities as it has at similar projects. Shopping Centers are traffic generators and competent attention must be given to this matter by all private and public planners.

Service

Much thought was given to truck movement and service for the stores. The ideal solution was to place everything underground, but the high cost made a compromise necessary. The plan used provides for a truck ramp into the basement of the garage, as shown in Figure 9. Here all of Hecht's receiving and relay operate, except for occasional large units that must be handled at a freight door off Wilson.

Likewise there are truck-high platforms for each of the Wilson and Glebe sides, with service corridors to neighbor stores. The occasional large trucks will use the parking driveways and load the hydraulic elevators for distribution through the service corridors.

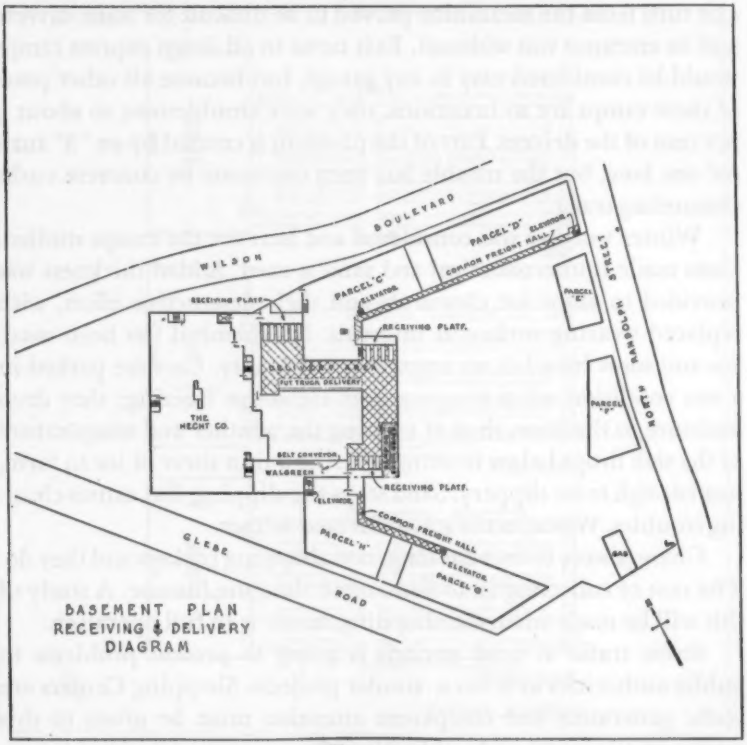


FIGURE 9.

Anticipating the Parkington will add sufficiently to volume so that Virginia deliveries will increase, a remote 15-route delivery station can be activated in the basement. Incidentally, suburban store deliveries in per cent of sales ought to approximate 50 per cent of the main store.

Utilities

Basic utilities of water, gas, power, telephone and storm and domestic sewers were available in the streets, and distribution within the project was developed to suit the need.

Central heating and air conditioning were weighed against separate facilities for each store. Economy and freedom from operating burdens determined the latter plan, except for those stores in the Arcade where (among other things) flues were not desirable. Here the boilers and cooling towers are in the garage penthouse, compressors are in the garage basement, and fans are in tenant space. Otherwise each neighbor store is equipped with its own air conditioning and heating, all units being gas fired.

Leasing

When the project was announced, many requests for space were received. The general occupancy objective was known, but the sorting and choosing of tenants was a huge operation. Having made the initial economic study, The Hecht Company knew every retail potential intimately, and made the leases on a guaranteed minimum plus a percentage of gross.

Basic specifications were drawn to fix the tenants' responsibility, and slight modifications were made to suit tenant needs.

Costs

Construction is now so far advanced that earlier cost estimates can be examined and future results well determined. The department store, complete with air conditioning, sprinklers, light fixtures, acoustical ceilings, elevators and motorstairs, and with provision for a future story, cost approximately $16 a square foot including architectural and legal expense. The neighbor stores, all air conditioned but not sprinklered, are costing approximately $22 a square foot based on the first floor area only. The garage is costing approximately $4.50 a square foot.

Costs for parking facilities are subject to the usual manoeuvering of figures, but brief comment may be helpful. Assume very cheap shopping center land, then its use for parking adds only 25 cents to 50 cents a square foot. However, when the center is successful, the land value is far more than its cost. A cost of $4.50 a square foot for multi-story parking could easily be cheap. Roof parking at from $1.50 to $2 also has its place in making comparisons.

Data

In this discussion of Parkington and outline of the general history of the project, only the high spots have been touched. Much could be said on any part of the project.

In addition to the foregoing cost figures, certain data on areas are of direct interest to those studying similar developments. Table I outlines the ground use of the triangular site, the important figures showing that of 600,000 square feet net in the site about 30 per cent was covered by buildings and 20 per cent devoted to walks, the mall, arcade and landscaping areas.

Table I

HECHT PARKINGTON

AREAS

			Square Feet
NET AREA IN TRIANGLE			600,000
GROUND COVERAGE			
Hecht Store	51,100		
"C" Building	26,500		
"D" Building	25,300		
"E" Building	7,200		
"F" Building	10,000		
"G" Building	21,000		
"H" Building	20,600		
Arcade	24,300	186,000	
Outside Parking and Drives including proposed Filling Station, 10,000 sq. ft.		198,900	
Ramps—North and South		13,400	
Garage Parking and Drives		77,800	
Walks, Mall and Arcade		123,900	600,000
GROSS AREA—PARKING, DRIVES AND RAMPS			
Garage	537,500 sq. ft.		
Outside	198,900		
Total	736,400 sq. ft.		

Table II contains the building areas and shows a present parking ratio of 2.8 square feet to 1 square foot of selling area. Parking for 420 cars in lots outside the triangle has been excluded.

Table II

HECHT PARKINGTON

AREAS

GARAGE BUILDING	*Square Feet*	
Basement:		
Hecht Receiving & Stock	41,000	
Walgreen Stock	6,900	
Small Store Receiving	13,000	
Compressor Room	600	
Truck Ramp	2,600	64,100
Ground Floor:		
Stores	24,300	
Arcade	11,400	
Show Windows	1,100	
Grade Parking	11,000	
Garage Parking	64,800	112,600
Mezzanine		63,600
Second Floor		124,700
Third Floor		123,100
Roof (Future 4th Floor)		123,100
Ramps		27,200
Total		638,400

SMALL STORES	*Square Feet*	
	Present	*Future*
"C" Building	54,700	79,700
"D" Building	52,300	52,300
"E" Building	14,400	14,400
"F" Building	20,000	20,000
"G" Building	43,200	43,200
"H" Building	42,000	61,200
Arcade Stores	31,200	31,200
Totals	257,800	302,000

ESTIMATED SELLING SPACE		
Hecht's and Small Stores	299,300	355,800
SELLING SPACE VS. PARKING SPACE		
Parking Area per Square Foot of Selling Area . .	2.8 sq. ft	2.4 sq. ft.

Conclusion

PARKINGTON represents another interesting project in the increasingly popular field of suburban shopping center development. The considerable experience gained by the Hecht Company in earlier developments of similar operations in the Washington area are reflected in this latest center.

A most unique aspect of PARKINGTON is its centrally situated multi-storied parking facility. The economies and conveniences resulting from this are efficient use of land areas and easy access to shopping floors from all parking decks. The soundness of this planning is attested to by the 3.3 daily turnover in parking already realized.

Other factors contributing to the successful development of this shopping community were the interested and valuable cooperation provided by local officials in the preliminary stages of the project and the close attention that was accorded all traffic aspects of the ultimate design.

The Grand Rapids Plan

HOWARD F. BAXTER

Until May 1, 1952, Mr. Baxter had been Chairman of the Grand Rapids, Michigan, Parking Authority for four years. He is an electrical engineer and a business executive. He is currently president and general manager of a chain of incorporated laundries operating in the middle west. He served six years in the Michigan state legislature, four of them as a state senator. He has served as chairman of the Welfare Advisory Council in Grand Rapids; chairman of the Utility Advisory Board; chairman of Civilian War Transportation; chairman of the Automobile Parking Authority, and as a member of the City Planning Commission.

METROPOLITAN Grand Rapids (Michigan) includes a population of 230,000 persons, some 700 industrial plants employing 49,000 workers on an annual payroll of $147,000,000. It has seven financial institutions having aggregate deposits and resources of slightly under a half billion dollars, and eleven hotels with 2500 rooms. It has what is reported to be the highest per capita automobile registration in the United States—one car for every two persons.

It faces the same parking and traffic problems as other cities, augmented by the fact that its central business district is concentrated within a small area paying 8 to 10 per cent of the real estate taxes. Those taxes are the primary source of city income. The usual neighborhood business centers have developed but are beginning to lose business to other centers being built just outside the city and providing adequate and free off-street parking.

The city commission adopted a recommendation of the Planning Commission and on September 8, 1947 created a Parking Authority of nine: The mayor, city manager, and seven business men serving without salary. There were three principles followed in selecting these men: (1) integrity and financial standing beyond question, (2) no direct interest in real estate near any possible parking site, (3) a record of non-political civic service. The purpose as expressed in that ordinance was to:

1. Formulate for public presentation a tentative master plan of automobile parking facilities as a guide for future provision of parking facilities.

2. Develop a program of construction.

3. Formulate methods of financing.

4. Recommend acquisition and control of parking facilities.

5. Maintain and operate public off-street automobile parking facilities then in existence or thereafter acquired by the city, or

6. Lease such facilities to private enterprise as the public interest may warrant.

All of the powers of the parking authority are subject to the approval of the city commission by appropriate action.

In accordance with the responsibilities placed upon the parking authority by the ordinance creating it, extensive surveys of the central business district and the community shopping centers were made by the city planning department and by a ramp buildings corporation, aided by an origin and destination study made by the state highway department.

The studies indicated a demand for 6000 more parking spaces in the central business district. Consideration of the location convenience of available sites and the effect of the size of parking facility upon traffic resulted in our deciding against large units and in favor of small ones with capacities below 400 cars.

Although members of the parking authority favored private enterprise, it was felt that public ownership was advisable because the right of eminent domain upheld by a unanimous decision of the Michigan Supreme Court, would be necessary to acquire suitable sites. Another advantage exists in public ownership in Michigan, as it includes the right to issue tax free revenue bonds to finance off-street parking facilities. This right was also upheld by a unanimous decision of the state supreme court.

City-wide support for the program was obtained by including from the initial stages, parking lots in the community shopping centers. The tentative master plan, publicly presented, included eighteen sites in the central business district and four in the community shopping centers. This was followed by appraisals, negotia-

Exterior View of Spiral Self-Parking Ramp Garage.

Interior View of Spiral Self-Parking Garage.

tions for purchase options, and estimates of parking capacities for each location. With these data available, the city commission authorized the employment of a full-time director; the ramp buildings corporation as engineers; a Detroit firm as legal advisors; another firm as financial consultants, and local architects for the first structure.

An ordinance was prepared, passed by the city commission after further public hearings, and approved by the Michigan Municipal Finance Commission creating an automobile parking system including both off and on-street parking revenues. The latter averaged $114,000 annual net revenue for the previous three years and is now above $122,000. It authorized the ultimate issuance of $2,435,000 thirty-year revenue bonds which are tax exempt and can never become a general obligation of the city.

Of this amount, $1,600,000 provide for three structures in the central business district, and $435,000 for four parking lots in four community shopping centers. These lots can be financed only if a competent engineering firm approved by the Engineer of the Michigan Municipal Finance Commission states they will be self-supporting. The balance of $400,000 can be sold any time before July 1, 1953 to provide facilities anywhere in the city, provided a similar satisfactory opinion is secured. The bond issue is open ended and further additional bonds can be issued after that date, provided the net revenues of the system for each of the two preceding operating years are equal to not less than 150 per cent of the highest annual requirement for principal and interest on all bonds thereafter becoming due.

The first $800,000 were sold at the interest rate of 2.33075, bids being received from twenty-four investment houses organized into seven syndicates. This provided for one five-level and the site for a three-level structure both in the central business district.

The five-level Municipal Ramp Garage was constructed. It is of the spiral self-parking type, has received most satisfactory public acceptance and has been a financial success. The city auditor reports that during the six months ended March 31, 1952 its revenues have been $39,707.83 and its operating costs exclusive of bond servicing

$14,570.44. Projecting the figures to an annual basis gives a net of $50,274.78 available to meet bond requirements. The cost of the structure including land approximated $530,000.

The city auditor reports that the revenues for the entire automobile system for the same six months were $107,560.72, and the expenses, excluding bond servicing, $29,281.49. Projected to an annual basis, the revenues would be $215,121.44, the expenses $58,562.98, leaving a net of $156,558.46 to service the $800,000 bonds now outstanding.

The four community shopping centers have been surveyed by the ramp buildings corporation. Only the Burton Heights shopping center was determined to be self-supporting. The City Commission recently passed an ordinance authorizing the issuance of $138,000 of the same revenue bonds to provide a parking lot for Burton Heights. The ramp corporation estimates the annual revenues of the lot at $9,198 and the city engineer estimates the annual operating expenses at $1,600.

The ordinance is now in the hands of the Michigan Municipal Finance Commission which is expected to approve it. The bonds then will be offered for sale.

Parking Problems and Solutions in Tennessee-Style

PAN DODD WHEELER

Mrs. Wheeler is the Publications Officer, Municipal Technical Advisory Service, The University of Tennessee, Knoxville. She serves as art and writing director for "Tennessee Town and City," the municipal league publication, and advises city officials on municipal reporting and the use of public relations techniques in city government. Mrs. Wheeler served as news editor at radio station WKGN in Knoxville and as public service editor for station WBIR from 1945–1949. She has written articles on municipal public relations as a professional in that field but "as a reporter" has covered many other activities of municipal government, both as a radio writer and currently for the Tennessee municipal magazine.

TENNESSEE people and the 240 cities in which they live or to which they go for selling and shopping have been receiving increasingly good money for crops or services. They have spent it freely, have patronized the local merchants, and have done their share of automobile buying and driving.

Therein lies a difficulty: more automobiles and more use of them.

From the smallest of Tennessee's urban centers, with populations of fewer than 1000 to Memphis with half a million, there is a problem of where to park the nearly one million automobiles that Tennessee people drive to their offices or plants, to the store, school, and shopping center.

Commented the *Lauderdale County Enterprise,* a newspaper published at Ripley, population 3307, "There is hardly a county seat in West Tennessee that can accommodate its traffic on busy days in the business district. Therefore, each must of necessity look to a sizeable parking lot not far removed from commercial areas." The *Memphis Commercial Appeal* has written, ". . . the parking problem (here) seems to be not a matter of inadequate supply but of improper location of available facilities with respect to demand."

This emphasizes the peculiar demands imposed by motorists for parking and traffic facilities.

The Public Works Planning Newsletter, published by the Tennessee State Planning Commission, summed up the situation like this in December 1949, "In nine out of ten Tennessee cities the parking proposition looms as one of the nightmares of city administration and most of the solutions proposed to date have fallen short of solving the difficulty."

That summary is still generally valid, but plans were made and effort expended by cities in the past year to solve parking troubles. These have included the establishment of municipal parking lots or definite plans for such lots; installation of parking meters; and provision by merchants of off-street parking facilities.

One Solution: Municipal Parking Lots

Memphis has reported on a survey of parking needs prepared by state and federal agencies with a $75,000 planning loan. The survey considered ninety-nine blocks in the Memphis central business district. The report indicates that 1340 additional parking spaces are needed in this "core area" and says that while there seems to be no deficiency of hour supply of parking spaces there is an inadequate supply in the location where demand for facilities is greatest. An underground parking lot in the place where space is most needed according to the survey, is now under consideration by Memphis city officials.

Nashville is utilizing a $90,000 federal planning loan on preliminaries for four municipal parking lots to serve its 173,000 "inner city" inhabitants. The plans are for one three-level lot with a capacity of 330 cars, a second four-level area to care for 400 cars in a space formerly occupied by the street-car depot, a third lot for 500 cars on the banks of the Cumberland River, and the fourth lot to be developed at the present railroad terminal after the railroads have moved their tracks to a new location.

Knoxville, population 124,000, has cleared space for a 500-car municipal parking lot directly behind the city hall. The space is to be graded, drainage facilities are to be built, and an asphalt topping

is to be placed. A charge will be made for the 500 spaces but the method of charging has not yet been decided upon. Also studies have begun preliminary to building a parking shelter within several hundred feet of the main business street.

Jackson, 34,000 population, has two new parking lots accommodating a total of 300 cars. The lots have good lighting and drainage facilities. The property was purchased by the city at a cost of $105,000. Clarksville, 16,208 population, formally opened two municipal parking lots in 1951. The first is located on property leased by the city, has a capacity of 102 vehicles, is well drained, lighted, and blacktopped. A meter rate of five cents an hour and 25 cents for all-day parking is charged. The second lot has been graded and a gravel surface provided. It is situated on property the city bought for the purpose.

Cookeville, population 6900, has two off-street parking lots, each with a capacity of sixty to seventy cars. At Tiptonville, 1945 people, a municipal lot has been graded and gravelled on a site leased by the city and located immediately behind the central business street. No charge is made for parking. Ripley, mentioned earlier as a county seat which needed a parking lot, opened two of them in 1951. The city bought sites for the lots at $15,000.

Newbern, population 1739, has gained wide recognition in municipal publications for the manner in which it financed a public parking lot. The city government borrowed money for the lot from a local bank on the pledges of Newbern businessmen. The pledges are being paid and the only cost to the city is the interest charges of 4 per cent on the loan. The Newbern lot is well-drained and lighted. It accommodates 100 cars and has six long spaces for farm trucks. City officials were given help by the Tennessee Planning Commission in selecting the site for the parking lot and in designing it.

More Metered Parking Spaces

Installation of parking meters has taken place all over the state. Tennessee's capitol city has installed 200 sample meters to "see how they work out." Location of the meters has been supervised by the city's traffic engineer. After a test period, if meters are installed

throughout the business area, they will be but part of a many-faceted plan for traffic improvements in Nashville.

Clarksville added 150 parking meters because, according to a city council report on the action, "people are not taking advantage of the sixty-five-car parking lot and short time parkers are crowded out of the downtown area." Mt. Pleasant, population 2925, paid for its $11,000 meter installation in eighty-two weeks (average take was $156 weekly) and is now enjoying what may be described as "profit" from the meters. Pulaski, population 5760, passed a city ordinance setting up a metered parking system and Monterey, a town of 2034 people, installed meters on a twelve-months' trial basis late in 1951.

In too many instances (Nashville is an exception), parking meters have been installed in Tennessee communities with attention of both city officials and citizens focused on revenue produced rather than on the real purpose (traffic improvement and an aid to enforcement of curb regulations) of metered spaces.

More than a year ago, the Municipal Technical Advisory Service and another University of Tennessee bureau sponsored a short course for mayors, city managers, and councilmen. The course dealt with facts these Tennessee officials needed to know in order to formulate and direct policy for the cities. Part of the program was devoted to parking. The city officials, many of whom were elected the prior summer and fall, responded to disclosures about parking in all instances with interest and in many cases with obvious surprise. One mayor confided that "he would have had less trouble convincing merchants that parking meters were a good thing" if he had known about meters as parking and traffic regulators "a little earlier."

Regulations Needed

While Tennessee cities have been slow to require off-street parking facilities of new public use structures, merchants and businessmen have increasingly provided such facilities either because they are convinced such facilities mean better business or because they want a "modern" structure and their architects have included parking areas in their designs. Even in the smaller communities a number of new bank buildings, churches, eating establishments and super

markets have provided paved parking lots for customers. The lots have good lighting and easy approaches from adjacent streets.

Experience shows however that city officials cannot depend entirely on economic and social factors to insure such developments. The state planning commission, a pioneer in the effort to help cities establish ordinances requiring a standard number of off-street parking spaces in new developments, points to the case of a grocery store operator in one Tennessee community as too typical.

"Why should I pay taxes," the grocer asked, "to provide parking for everybody?" He had originally built his store with ample parking facilities but later planned to expand the building proper, doing away with the parking lot. "My customers," he complained, "hardly get a chance to use the space. One of my rivals has built next door to me, provides no parking space, and his customers use my space as freely as does all the rest of the community." A solution is enactment of a municipal ordinance requiring that a building devoted to public use must provide for parking facilities adjacent to it.

Tennessee's city officials do not have to work alone on their parking problems. The state planning commission will help prepare zoning ordinances of the type just mentioned and also assists local planning groups in determining the number, location, and design of municipal parking lots. The Municipal Technical Advisory Service provides consultants who are available to city officials for assistance in helping formulate policy for dealing with traffic and parking problems, in devising ordinances for parking regulation, and in working out engineering problems and related matters in the parking field.

Public Relations in Parking

The Municipal Technical Advisory Service can help cities in another way—planning how to inform the public about parking matters. The city that obtains the support of citizens in its parking projects is the city whose officials are themselves well informed about the problems and who have consistently, over a period of time, fully and truthfully informed the public about the city's project.

It is normal for citizens to react unfavorably to city council's expenditure of $140,000 to buy land for a municipal parking lot—

unless those citizens have been conditioned by preliminary information-education. It is natural for citizens and merchants to balk at installation of parking meters unless they have been kept informed about the need for turnover in parking spaces and the ways in which meters can benefit motorists and merchants alike.

The principle of informing the public about the public's business is particularly applicable when a city government tackles parking matters. The reason is obvious: parking touches a large percentage of citizens personally and consistently. These people are naturally interested in the subject and are likely to be attentive to information-education from city hall about parking.

City officials in Loudon, Tennessee, population 3566, applied good public relations to their recent parking meter project. Discussions leading up to council action were covered in detail by the local newspapers and officials were truthful and candid in their answers to reporters covering council sessions on the subject. When specific proposals for an ordinance were made, the city government published these in the local newspaper. On the same day, an interpretation of the proposals was given prominent attention in the newspaper's editorial and news columns. After the ordinance establishing metered parking was passed, the city issued 3,000 circulars and delivered these to each household and business establishment in Loudon. The circulars explained what the ordinance provided and what the meters meant to the everyday citizen.

These several examples of how Tennessee cities are attacking their parking problems must not be interpreted as proof that an end has been reached. Like local government units in other states, Tennessee cities have too little money with which to work, interested but often misdirected pressure groups to satisfy, apathetic citizens to arouse, and other matters as pressing as the parking problem, which demand the time and energy of their officials.

The progress in Tennessee communities in 1951, however, is evidence of the kind of activity generated when officials and businessmen and citizens and technical helpers interact with one another to examine and plan an offensive against the parking problem.

The Berkeley Plan: A Cooperative Parking Lot Project

JAMES W. MEYER
AND RICHARD GALLAGER

Mr. Meyer worked with a consulting civil engineering firm in Berkeley for four years. After that he worked with the Institute of Transportation and Traffic Engineering, University of California, mainly in the field of research in off-street parking. He is the author of "Off-Street Parking in 79 California Cities," Western City magazine, March 1951. For the last year he has been Traffic Engineer for the City of Berkeley, Department of Public Works.

Mr. Gallagher, one of the first graduates of the Yale Bureau of Highway Transportation, served in the Civil Engineers Corps of the Navy and then became the first consulting engineer in the West to devote his full-time practice to parking. He was Director of Public Works in the City of Berkeley for three years and in January of this year became Director of Public Works in the City of San Diego, California. Mr. Gallagher is a registered civil engineer in the State of California.

BERKELEY has started its attack on the off-street parking problem. The first municipal parking lot in the city is now under construction. It will be a 105-car metered, limited-time shopper lot located within 200 feet of the center of Berkeley's second largest business district. Its physical characteristics will conform to accepted standards for design, layout, and operation, but its history is unique.

Its uniqueness lies in cooperative financing. The city has provided—from parking meter revenues—a little more than half the money, and the merchants and business property owners have provided the remainder. So far as we know, this is the first time in the country where business people and the city have cooperated on a completely voluntary basis to finance an off-street parking facility; that is, without the use of revenue bonds, assessment districts, validation schemes, etc. It is a healthy enterprise indeed, both for the city and for the businessmen.

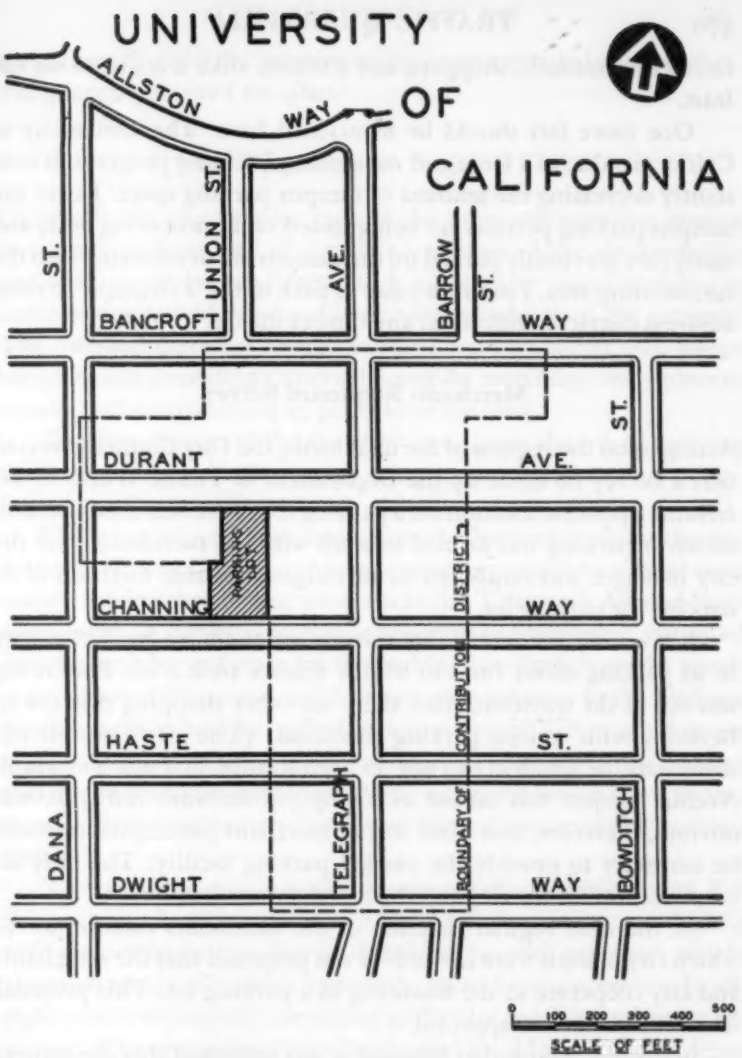
At a meeting of the Berkeley City Council more than two years ago the merchants in the Telegraph Avenue business district requested an immediate survey in an effort to find a solution to their parking problem. The parking problem in their district was so acute, they said, that some of the merchants were being forced out of business.

Heavy Parking Demand in Campus Area

The Telegraph Avenue business district is the second largest in the city. In it are some 150 retail stores, a large medico-dental building, a theatre, two hotels, and some excellent restaurants. For the most part the district is characterized by narrow streets, long blocks, and large, old frame buildings.

Bordering the north end of the business district is the campus of the University of California, which occupies a 400-acre tract with more than one hundred academic and administrative buildings. Twenty-five hundred faculty members and employees park their cars on the campus and more than 4,000 students regularly park immediately adjacent to the campus, many of these in the Telegraph Avenue business district. It is bounded on the east and west largely by student fraternities and rooming houses. In this area the demand for long-time parking space is the greatest of any district in a city plagued by a generally grave parking problem. One can readily see the impact such an unusual concentration of vehicles makes on this comparatively small district.

Curb parking space in part of the district is metered with 212 one-hour parking meters. A great deal more curb space is devoted to non-metered one- and two-hour time limit parking. A recent survey of parking characteristics in the Telegraph Avenue business district disclosed that more than 50 per cent of vehicles parking in time-limit zones were parked longer than allowed. Furthermore, 40 per cent of the total of parked vehicles in the one-hour zone used more than 70 per cent of the available space hours, the survey revealed. Needless to say, the practice of "meter feeding" is common. Even with excellent police enforcement we were unable to effect substantially more efficient use of curb parking space. The problem



TELEGRAPH AVENUE BUSINESS DISTRICT

Map indicating the location of the parking lot with respect to the contribution district. The contribution district encompasses more than 70 percent of the retail stores in the Telegraph Avenue business district. Note the access to the parking lot from two streets.

facing businessmen, shoppers, and students alike is acute, to say the least.

One more fact should be mentioned here. The University of California, due to a large and continuing building program, is constantly decreasing the amount of campus parking space. Fewer on-campus parking permits are being issued each succeeding year, and many cars previously parked on the campus are overflowing into the surrounding area. Finding a place to park in the Telegraph Avenue business district is difficult at any time of the day or night.

Merchants Requested Survey

Acting upon the request of the merchants, the City Council directed that a survey be made by the Department of Public Works to determine a possible location for a parking lot. A council committee on off-street parking was formed to work with the merchants, and the city manager was requested to investigate possible methods of financing the parking lot.

It was soon discovered that the city did not have enough money in its parking meter fund to wholly finance such a lot. Borrowing was out of the question, since there are other shopping districts in Berkeley with serious parking problems. (The city's overall off-street parking problem had not yet been studied, and this Telegraph Avenue project was meant as a stop-gap measure only.) It was obvious, therefore, that some sort of merchant participation would be necessary to provide the needed parking facility. The only alternative was for the city and the merchants to join forces.

At the next regular meeting of the merchants association—to which city officials were invited—it was proposed that the merchants and city cooperate in the financing of a parking lot. This proposal met with immediate approval.

In the discussions that followed it was suggested that the owners of the business property affected also contribute to the parking lot since, for the most part, they were "absentee" landlords and merely leased space to the merchants. They could be dealt with as a separate group and "they stand to benefit just as much as we do," the merchants felt. This proposal also won approval of the merchants

association. Some of the property owners were sounded out, and they too, generally favored the plan.[1]

Financing the Project

Originally the plan was for each of the three participating groups to contribute one-third of the lot's total cost. After the probable cost of a 100-car lot was determined, however, it was clear that the businessmen would not be able to bear two-thirds of the amount. The plan was therefore altered to provide for financing on a 50–50 basis; the city providing 50 per cent, and the merchants and property owners each contributing 25 per cent of the total.

The Department of Public Works was given the job of defining the "contribution district" and setting up the machinery for pledging of contributions. Fortunately, this was a comparatively easy task.

There was general agreement from the beginning about the size of the lot. It was felt that one hundred spaces would be a good start toward solving the parking problem in the Telegraph Avenue business district. A survey of available property in this district indicated that the most logical place for the parking lot—both from the standpoint of acquisition costs and location with relation to the business district itself—would be in the block just west of Telegraph Avenue in approximately the center of the business district. It was decided that the lot should extend through the block and would front on two streets, thereby giving a more direct access to more of the business district.

The next stop was to make an estimate of acquisition costs. For this purpose a local appraiser with many years' experience in dealing with properties in this district, furnished us with estimates which, although admittedly quick appraisals, proved quite accurate. In all, eight pieces of property averaging 50 feet by 130 feet each were appraised. The properties were all occupied by old multiple-residence frame buildings that would have to be torn down for construction of the parking lot.

[1] This appears a more advanced and realistic view than property owners' earlier attitudes reported in December, 1946, in "Parking," a guide published by the Eno Foundation authored by Wilbur S. Smith and Charles S. Le Craw. They reported that few retail property owners then were "willing to go to the expense of providing off-street facilities". . . .

After determining approximately the amount of money necessary to acquire four of the eight lots—which would accommodate more than one hundred cars—a "contribution district" was formed. All those merchants and business property owners within 800 feet walking distance[2] from the proposed lot were considered as benefiting directly and contributions were assigned to each of them.

The 50 per cent contribution to be provided by the merchants and property owners was divided equally between the two groups. For the merchants, the approximate gross income was used as a basis for proportioning the contributions. The 25 per cent of the total cost charged to the merchants was distributed among them according to the amount of business done, the smallest contribution being $1 a month and the largest being $20 a month, payable in ten yearly installments.

The assessed property valuations were used as a basis for division of the contribution by property owners. Their contributions were established by comparing the individual assessed valuations with the total 25 per cent needed. Each piece of property was assigned a contribution according to its percentage of the total property evaluation. The property owners also may pay their pledges in ten equal yearly installments.

Formal agreements for the pledging of contributions were drawn by the city attorney and submitted to the merchants' committee assigned the job of obtaining signatures. They spent nearly a year in getting the individual merchants and property owners signed up to contribute to the off-street parking fund. After this period, it was decided that no more time should be used in obtaining pledges since some of the merchants and property owners had expressed their concern over the delay of the project.

A resolution was prepared for the City Council for acceptance of the total contributions thus far pledged. Provision was made to accept contributions even after the start of construction of the parking lot. As it worked out, contributions on the part of the merchants and property owners amounted to 36 per cent of the total—some-

[2] The 800-foot criterion was inspired by the findings of R. H. Burrage and S. T. Hitchcock of the Public Roads Administration in Highway Research Board Bulletin #19, which comments that the proportion of parkers "walking more than 800 feet (2 blocks) is relatively small in the smaller cities."

what short of the 50 per cent goal originally established. The City Council, however, felt that this indicated serious intent on the part of the businessmen and therefore unanimously approved the resolution providing for negotiation of the signed agreements and acceptance of the contributions.

The city manager, at the same time, was directed to proceed with property acquisition. (As had been expected, a few of the businessmen expressed some reluctance about contributing to the project, and some did not contribute at all. To offset this, however, several of the merchants and property owners outside of the contribution district pledged contributions voluntarily, since they realized they would also benefit substantially from increased parking space in the business district.)

Cost Per Car Space, $1500

The Department of Public Works had previously submitted to the city council committee and the merchants' committee on off-street parking five different proposals for using portions of the appraised property. One of the proposals, for a parking lot using four of the properties and accommodating 105 cars, was agreed upon by both committees. A total of 30,000 square feet is being used for the parking lot. The cost per car space including demolition, construction, and parking meters, is approximately $1,500.

The lot will be surfaced with dense-graded plant mix, with provision for drainage and lighting. Cars will park diagonally on one-way aisles, but it will be possible for motorists to leave by the same street from which they entered, by using an open area in the center of the lot for turning into an exit lane. The parking meters will be in effect from 9 A.M. to 6 P.M., as are the curb meters in Berkeley, and will be enforced by the regular police officers assigned to the district.

The revenue from the parking meters is being used to pay taxes on the acquired property. In this way the property is not being taken from the tax rolls, thus eliminating one of the usual objections to public ownership of parking facilities. Conversely, certain objections to private ownership of public parking facilities are over-

come, including: (1) hazard of future loss of use since the title is vested in the city and permanently dedicates the property to parking; (2) businessmen's contributions not only are guaranteed against arbitrary increases, but will cease entirely after a decade, while service continues; and (3) reasonable and non-fluctuating charges are insured.

Because of the time limit and simple enforcement, it is expected that the parking lot will be used largely by short-time shoppers during the day. At night the lot will serve the theatre, churches, restaurants, a hotel, and of course the students. A large sign is to be placed in the center of the lot indicating that "This parking facility was made possible by the City of Berkeley and by contributions from the following merchants and property owners. . . ." This advertising plan was responsible for several pledges by businessmen who perhaps otherwise would not have signed agreements.

The lot is expected to accomplish a great deal in more efficient use of nearby curb parking space, in increased convenience to the motorist, and by reducing congestion caused by drivers searching for a place to park. Most important, this lot is an excellent example of cooperation between private enterprise and government—both on the personal level and as official organizations—to produce a parking facility that would be out of reach of either group individually. Both groups, as well as the harassed motorist, benefit directly.

This is the Berkeley Plan. It is not the final solution to the growing parking problem in the Telegraph Avenue district, but it is a promising beginning. While many methods are available to provide off-street parking, we feel the plan merits thoughtful consideration by cities with comparable conditions.

Off-Street Parking in Columbus

WILLIAM R. MORRIS

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THE rapid growth of Columbus in recent years has been accompanied by a large increase in the number of people who desire to drive into and park within the Central Business District. The result has been a demand for parking space that substantially outweighs our present capacity of curb and off-street facilities.

Not unlike other cities, within the last four years multi-unit shopping centers providing most of the attractions of downtown shopping have been developed in suburban areas in and around Columbus. This outside attraction has resulted in a reduction in the patronage of the downtown area and ultimately is reflected by decreased property valuations and lowered municipal revenue from property assessments. It is readily seen that unless additional conveniently located parking spaces are provided in areas of maximum demand, the economic stability of the downtown area as well as the financial well-being of the entire city will be adversely effected.

Those two statements are compatible. Columbus is the state capital and has federal, state, county and city offices in its downtown area employing more than 29,000 persons. Columbus is one of the three leading convention cities of the country and as a hub of the motor truck business has seventy-five motor freight lines. The greatest point in resolving the statements above is the figure on motor vehicle registration for the Columbus area. In 1940, there were 123,134 registered vehicles, in 1950 there were 184,831 a percentage change of plus 50.1 percent.

This, then, was our problem when on June 26, 1950 Mayor James Rhodes created the Columbus Motor Vehicle Parking Commission. The commission was made up of public spirited citizens of Franklin County who had become keenly aware of the pressing problem

presented by inadequate parking facilities in the city. The first studies by the commission revealed that a statute enacted by the Ohio State Legislature in 1947 and later revised in 1949 authorized municipal corporations to lay out, establish, construct, maintain, and operate off-street parking facilities.

A 1936 Supreme Court decision, however—City of Cleveland vs. Ruple 130,OS, 465—created substantial doubts as to the legality of municipal off-street parking operations. The Supreme Court held in the Ruple case that the City of Cleveland could not use parking space under a municipal auditorium for a commercial parking garage in competition with private business. With this cloud hovering over the parking situation, the commission determined that a law suit would be filed to test the authority granted municipalities by enabling legislation.

As a result of this action, the Supreme Court in two decisions[1] established the legality of municipal off-street parking, and held, subject to certain conditions, that revenue bonds and general obligation bonds for such a project can be issued under the city's constitutional home rule power.

Study and Recommendations

The court had no difficulty in distinguishing the 1936 decision. After fifteen years, traffic problems are so much more aggravated that the change in conditions would have been enough to justify a reversal. It was soon determined, however, that victory in the Supreme Court didn't provide a panacea for our parking ills. Certain definite requirements of the parking law make it difficult to acquire, finance, and profitably operate a municipal parking facility (a) real estate acquired is not tax exempt (b) the right of eminent domain does not apply to real estate on which off-street parking facilities, open to the general public, are and have been established for one year prior to acquisition (c) municipalities cannot sell tires, gasoline and accessories in conjunction with a parking facility.

The Commission, quite fortunately, is made up of men who can

[1] Announced on July 11, 1951.

see the moon in their planning and still not overlook the sixpence at their feet. They had not been sitting idly by awaiting the Supreme Court's decision. Business interests of the city had been solicited and funds raised to engage a consulting engineering firm to make a study of parking facilities in the central business district in order to formulate a program for the development of off-street parking facilities and to make recommendations relating to a solution of the parking problem. Preliminary engineering reports were received by the Commission Sept. 15, 1951.

The recommendations of the reports include the construction of two parking garages with a total capacity of 947 stalls to provide parking space for shoppers and business clients for a two-to-five hour period, and the elimination by enforcement of overtime parking at legal curb spaces to provide additional parking spaces for the one hour parker. The proposed garages would be located on sites easily accessible to the areas of high demand in the inner core of the central business district. The report estimates the project would cost $2,600,000. This represents the size of the revenue bond issue required to finance the facilities.

Average annual revenues are estimated at $212,200 and maintenance and operating expenses at $125,000, taxes at $14,600. The report concludes that the project is definitely not self-liquidating and will require a subsidy or contribution. The amount of additional funds necessary will vary with the method of financing selected. The reasons why this project is not self-liquidating are the high capital costs, the restrictive measures of the Ohio Parking Law, and the necessity of a moderate parking charge.

Parking Department Established

Realizing that permanence and direct responsibility are integral components of the success of programs like this, Mayor Rhodes and the city council on Dec. 22, 1951 established the Department of Off-Street Parking and in the department provided for a Commissioner of Parking and other necessary personnel. At this time, the old Columbus Motor Vehicle Parking Commission was discarded and a new advisory Off-Street Parking Commission created.

All of the original members of the Columbus Motor Vehicle Parking Commission were retained and two new members added. The Commission is now made up of R. F. Shawan Jr., chairman, a retail furniture dealer; Harry L. Ludwig, vice chairman, owner of the Neil House Hotel, and members Arthur G. Frank, secretary of the Convention Bureau; D. Wendell Beggs, real estate broker and owner of a large office building; Walter P. Reiter, vice-president of a bank; Al Vesy, secretary of a labor union; George Byers, automobile dealer and a parking garage operator, and E. Stanley Jones, executive of the Farm Bureau.

The gratituous service of these men is to advise the Mayor and Commissioner of Parking upon all matters pertaining to off-street motor vehicle parking within the limits of the city. The Department of Off-Street Parking is established for the purpose of providing sufficient parking space for enough motor vehicles in order to relieve traffic congestion and to provide for the flow of traffic and for parking off the public streets. The department is empowered to acquire sites and to lay out thereon and establish, construct, maintain and operate within the city off-street parking facilities for motor vehicles including buildings, ramps and underground structures and facilities incident to the operation of such properties for the parking of motor vehicles.

The preliminary engineering report for downtown Columbus was turned over to the new Off-Street Parking Commission and it was determined that this report would serve as a basis for the overall parking plan for metropolitan Columbus. The formation of the overall plan, it was soon learned, was hazardous; and though it might be years before the full results could be evident, those results when achieved could be tremendous. As a result the legal and financial problems, in a technical sense, were turned over to a committee made up of the city attorney, the bond house with whom city council had negotiated the sale of $4,500,000 mortgage revenue bonds, and the commissioner of off-street parking.

The technical work relating to areas of influence on parking and the correlation of problems involving both the pragmatic and aesthetic, is being carried out by a committee made up of the city's planning director, traffic engineer, expressway expeditor and the

commissioner of parking. The reports of each of these committees will be submitted to the off-street parking commission for approval and they in turn will make their recommendations in final report form to the mayor and city council for their action.

The choice of a feasible financing plan presents many problems. It is important to effect a fair destribution of the cost of providing and operating public off-street parking facilities as between the users and non-users. Among the methods to be considered by this study group are:

Capital Revenues:

If a city were debt-free, this method would be feasible. Current revenue in a fiscal year to provide substantial funds for capital outlay is practically unheard of in municipal government. With appropriate legislation, a fund might be accumulated for future capital outlay by making contributions to the fund under the annual budget. This procedure, however, would not placate the pressing problem demanding immediate action.

General Obligation Bonds:

This method of financing contemplates the issuance of bonds by the city with an unconditional promise to pay and is supported by the city's power to levy taxes. This type bond must be issued within the confines of constitutional and statutory debt and tax limitations. In this type of financing, the user as well as the non-user supports the facility.

Special assessment financing:

This is a form of taxation. General taxes are imposed on the theory of general benefits of government extended by the taxing authority. To justify a special assessment the tax must be laid for a special purpose that will benefit the property taxed to a degree not true of property not assessed. Whether or not the special assessments approach could be used in case of an off-street project would depend in part upon the location and particular purpose of the project. There is some legal basis for special assessments for off-street parking projects in states other than Ohio.

Revenue Bond Financing:

This method entails issuance of mortgage obligations payable solely from the income from the revenue-producing parking facility. These bonds are retired by the user of the facility. Revenue bond financing has come of age as a sound method in proper cases. In adapting this method to off-street parking one must recall that there is only a brief history for the investor to examine. With high costs of land, construction and maintenance anticipated gross revenues provide only thin coverage of debt service requirements, and unless a sound financial program can be presented, investors will be difficult to interest.

There are, however, avenues as yet not legally established in Ohio, that could be used to "fatten" the coverage needed. Some of the so-called avenues are the providing of incidental services such as the sale of gasoline and automobile accessories, another is a pledge of net revenues from on-street parking or parking meter funds. Both of these sweeteners however have legal objections that would require Supreme Court tests.

Combination issues:

In this method of financing, general obligation bonds would be issued for the purchase of land and mortgage revenue bonds issued to finance the construction of the facility. This method contemplates the revenue from the facility retiring only the mortgage bond issue and in effect lends the city's security to the mortgage issue in that the land would be part of the security pledged to the mortgage bond holders. There are many hurdles that must be jumped before this method would be acceptable.

Junior mortgage bond issues:

This method of financing has many attractive points. It anticipates the issuance of approximately 60 percent of the issue (mortgage revenue) as senior bonds carrying a normal interest and retirement rate, these bonds to be sold to general investors. The remainder of the issue would be sold to local business people who have a definite stake in the solution of our problem.

These junior bonds which are free from both the normal and surtax rates of federal income taxation, would carry a low interest rate and a retirement schedule starting after the senior bonds are retired. It is quite possible that much less than 40 percent of the issue would need be placed as junior bonds if land and construction costs are reduced to the minimum. By this method of financing, local interests can assure the immediate start of a building program and have some return on their investment and eventual retirement of their bonds. This method does have the additional attraction of having no apparent legal barriers.

Traffic Facts Turned Up

Which one of these methods or combinations of methods will be used in Columbus is as yet not determined. Many factors must be considered before a final decision is made.

The technical group turned up some startling facts concerning automobile traffic and parking habits in Columbus. For example, in Columbus we have approximately 650 miles of paved streets and alleys and have in registered automobiles the equivalent of more than 700 miles of automobiles, bumper to bumper. Another fact pointing up the problem is that we have enough registered automobiles in the Columbus area to ride every man, woman and child in Columbus and require not one person to ride in a back seat. At the present time there are 30,000 passenger car destinations in the downtown area of Columbus. Between 8 A.M. and 5 P.M. approximately 25,000 passenger cars are parked in the area and there are only 10,424 legal on and off-street parking spaces available. A survey of the inner core of the downtown area revealed that better than 50 percent of the cars parked there were parking illegally.

It is quickly apparent that there are many related problems that must be considered in the general overall parking plan. Related problems such as curb parking, parking meters, enforcement of parking regulations, zoning for loading and unloading and parking, mass transportation, expressway systems, building codes requiring off street parking and city planning are all to be considered before a comprehensive and effective program can be presented.

The approach to the solution of our parking problem is likened to the health problem of the human body. When the heart begins to fail, action must be taken to stimulate the heart so limbs and the body as a whole can remain healthy. The heart of Columbus (the downtown area) is having heart angina. Its limbs (suburban and fringe areas), are feeling the effect. Some form of stimulation must be administered if the city is to remain healthy and prosperous. We who are interested in making Columbus the greatest city in America welcome any form of stimulation. The stimulant may be in the form of private capital or public money, or a combination of those resources. We expect to continue, as we have in the past, to work all ends toward the middle in the accomplishment of the job we have taken on.

Psychological Factors in Driving

DR. D. J. VAN LENNEP

Dr. Van Lennep, professor of psychology at the University of Utrecht, is president of the Netherlands Foundation of Industrial Psychology. He is a member of the Medico-Psychological Committee of the Royal Netherlands Automobile Club where traffic forums are discussed and governments advised. The Foundation at Utrecht makes examinations for the industry of Holland. It tests pilots and bus drivers.

EVERYONE concerned with traffic problems feels the need of a precise insight into what driving, psychologically speaking, actually is. The light that psychology can shed on this problem depends of course upon the status of the science itself. Compared with twenty years ago, psychological driver-testing today shows that insight into drivers' psychological background has undergone important changes.

Here is a psychological view of driver-activities, based upon the ideal driver. There are various driving methods, all with their own psychological backgrounds.

The problem is extremely complicated; we make no pretense of handling it completely. We do hope that what follows will bring to light a few important aspects of driving.

The driver's work-object is not the automobile, but the road. His goal is his destination, but his field of work is the road. His task is to traverse a section of road. His instrument is his automobile. This he must know and be able to operate as well as possible. In the modern automobile, that is becoming more and more simplified. In America, there are automobiles in which the driver does not have to shift gears.

The 'Road Situation'

When we speak of *road* in this connection, viewed psychologically, we do not mean merely this length of gravel, cement, or asphalt surface, but the *total road situation* with its eventual trees, side streets, pedestrians, bicycles, automobiles, curves, and traffic signs. This total road situation, this constantly changing sometimes un-

predictable complex, comprises the special world of the driver. The term "world" has a definite meaning for the modern psychologist. It is something in which the individual himself, in our case the driver, is present in a definite manner and with which he is inextricably bound in a special way. In the world of the driver, the driver himself is actively represented, not as an outsider, not as an observer, not as a sort of reaction machine reacting automatically to a field of stimulation. The driver is represented as an active entity which, as well as accepting the objective meanings, also gives meaning to the whole complex of data. Of this data he is an inextricable part. He makes decisions on the basis of those meanings.

The world of perception in which the driver finds himself and which forms the object of his activity is a complex of definite meanings—as is every "world." The parts of this whole complex have an entirely different meaning for the driver than for the other users of the road; for example the pedestrian. A streetcar is something to pass on the right side; an automobile, something to pass on the left. Briefly, the special meaning of each thing changes according to the world in which it for the moment belongs. Also the space and time of the different worlds are not the same. The pedestrian lives in a different space from that of the driver. Thus 500 yards, or sometimes one mile farther, belongs to the space of the driver; he must take into consideration what is going on out there in the distance. The space of the pedestrian, on the other hand, is limited to several yards, or at most twenty or thirty.

And all these special data in this special space, which also changes its aspects in a much shorter time than for the pedestrian, are ordered according to a special structure.

One has heard it said: the driver must deal with a widely spread attention. This commonly means he must be able to divide his attention over many objects—a supposition that does not agree with reality.

What 'Widely Spread Attention' Means

What is actually meant by this so-called widely spread attention is the case in which the natural or real center of gravity of the field

of perception—for the driver, the route with all its other traffic in the direction of the length of his automobile—does not coincide with the constantly changing focus in the field of perception (the turn again to the left, then again to the right, then straight on, then a sudden slowing down) independent of whether the attention is involuntary —that is to say determined by the objective configuration of the field of observation, or voluntary, as at an intersection when the driver looks for the traffic coming from the left and right.

This supposition is based upon an old attention theory that supposes our attention should be a sort of searchlight we can throw upon the things in our environment to see them better. This theory separates the function of attention from the things upon which attention must be directed.

Attention is the way we relate ourselves to objects upon the basis of the meaning they have for us when we perform a task. Therefore, we can never separate attention from being concerned with things and their meaning in our field of action.

In the case of the driver we must ask directly: what must he perceive in the traffic objects in his field of perception. Simply and only their traffic meaning in the situation in which he finds himself. Thus their traffic meaning for him.

What do I perceive, for example, in the case of an automobile parked on the right side of the street forty yards ahead? Not its make, not its number, not whether it is new or old, or whether its fenders are dented, but only that it is something that must be passed on the left side; or even better, the automobile is for me the signal to look out around it while still allowing enough space on the left. The automobile remains in this case *marginal consciousness.* I do not focus my attention on it; its only meaning for me is that it changes the section of road twenty-five yards in front and behind it and five yards to the left. The context of the road situation is altered and the perceiving of that automobile means that with definite movements, or the anticipation of definite movements with a driving plan, I can adjust to the newly altered traffic situation.

This does not say that I react to that automobile in the sense of a stimulus-reaction scheme. Rather, I have answered the whole traffic

situation with an entirely new adjustment of me-in-my-car-in-the-situation.

No one can give attention to everything at once. To do so would be unnecessary, even undesirable. Certainly, the driver must have a fairly wide *field* of attention. He must see with one glance what is going on to the left and right of him and what will happen to him farther on. But he sees this in a definite structure in which the *important* and the *unimportant* are differentiated according to the *meaning* the things have for him in his own situation, and which he gives them on the basis of his own insight. As always, perception hardly occurs before the objects of the field of perception are structured in a figure and a background. On the background of houses, road surface, trees, certain objects stand out as the figures in our field of attention. This is just as true for the pedestrian as for the driver, but the driver pays attention to other figures than the pedestrian.

Not a Static Complex

This complex of meanings is not static, but changes constantly. What was background—a parked car for example in the distance upon which no attention was necessary—becomes a figure, one second later. On the other hand, an automobile that one must pass can change from *figure* to *background* even before the passing is complete, if one is certain that "nothing more can happen." This complex of meanings, which can include a large field of attention, requires no typical, distributive attention. The complex, composed of figure-background, must be seen and judged with one glance. There are no loose, isolated elements since these elements are mutually related for the driver. The changing of one element changes the meaning of another element. One could speak of a physiognomy of the road situation. This constantly changing physiognomy must be constantly surveyed and judged in its entirety.

Traffic regulations are of great assistance in the objective structuring of the field which makes this survey possible.

An automobile or other user of the road, who does not follow the regulations, but makes use of the road according to his own choice or impulse, breaks through suddenly as an isolated element

in the total structure of the situation because his movements were unpredictable for me. For this reason, since our structure then suddenly threatens to fall apart, the chance of an accident is great.

Traffic rules function also to make it possible for us to oversee the traffic situations in their entirety. Thus, by the traffic laws, all objects which are here dealt with, and, as it were ordered, are fitted into a structure which makes it easy for us to perceive and to reply to the situation. In not too complicated situations, driving can even become marginal with respect to our intellectual activities. It can, however, never become unconscious. A world is always a *social* world. There are *other* users of the road. The other automobiles I pass or overtake are not *things* and nothing more, such as a house or a tree, but things driven by my fellowman.

The road situation as object of the driver is pre-eminently a social situation. If I found myself only among "things" on the road, the psychological analysis of driving would be entirely different, just as it is, as a matter of fact, quite different for the "race-driver." The activities of the driver take place, therefore, pre-eminently in a certain society. For the good driver, the other users of the road are not traffic obstacles in the way to his goal, which he must try to "overcome" as cleverly as possible. The normative background of the traffic laws is thus also that the users of the road ought to use the road *with* each other.

This conception is difficult for the average driver but it is understandable, because different users of the road have the same object, "the road," but all a different goal which they—and this is precisely what the automobile is for—individually try to reach. And where a common goal among men is lacking, there is rivalry, there is egoism.

There is thus in every driver a continuing struggle between two contradictory tendencies. The individual goal must be reached in fellowship with others who are striving also for their individual goals.

Unspoken Language of the Road

The driver must thus judge the road situation as one judges the physiognomy of someone with whom he is involved in a conversation. One reads from this changing physiognomy the intentions of

his partner. A good driver "feels" where the other wants to go. There is on the road an unspoken sign language (of which the direction signals are the crudest representatives), which *good* drivers speak with each other.

This judgment applies to the whole road situation, including the traffic signs. The interpretation is thus partly according to standing agreements, the traffic laws, and partly according to immediate intuition. He who can not listen is usually a bad driver. One must take into consideration and listen to the very special expression phenomenon of each other user of the road.

We have already said that the perception of the road situation is closely related to the operation of the automobile. We must now return to this earlier statement. The driver does not *drive* his car through the traffic situation. This manner of expression gives the impression that the driver, as it were, stood outside his car and manipulated it as an object among other objects.

The good driver is one entirety with his car; that is to say, the automobile becomes a part of his body. A peculiarity of any instrument is that one uses it as an extension of his own body. One might say that when we draw a line in the sand with the end of a stick, our feeling is transferred to the end of the stick. The driver is as wide as his car. He does not measure whether he can go through a narrow place, but feels this after a certain length of experience.

But he feels this only as long as he sits behind the steering wheel. One sitting next to the driver experiences all the misery of the so-called "backseat" driver. We are terrified by objects for which we would have no fear if we ourselves were behind the steering wheel. That occurs because, if we can drive, we see the road situation *with our pedals* and *with our steering wheel.*

That sounds strange to the psychologically unschooled. Indeed, the truth is that not only, as was earlier thought, are our driving reactions dependent upon our perception, but also our perception, which in practical living is always a pragmatic perception, is at the same time dependent upon our being busy with driving. We only see how a situation is for *us* when we ourselves are actively engaged in it.

Quite Different View Behind the Wheel

Anyone who has ever changed places with the driver and, after being a passenger, has suddenly taken his place behind the steering wheel knows how the world at once changes its aspects. The complex of meanings is entirely different when we sit next to the steering wheel from what it is when we sit behind it. We observe other things and other aspects of the same things. The figure-background relationship undergoes a fundamental change. A pretty girl, who for us as passenger would be a figure, is now suddenly background, or at least ought to be. An opening in the traffic, which we earlier could not possibly judge as to whether it would be possible to get through, is now, when we are sitting behind the steering wheel and with our feet on the pedals, appraised for its real worth without hesitating.

But, in the second place, we must also consider in our judging of the situations the judging of the coming, not yet real, situation. We can express this by saying that we must see ahead in space and in time.

In space, we must not be concerned only with what is going on immediately around us, because in just a few seconds we shall be perhaps hundreds of yards farther. We must, therefore, in the literal meaning of the word, see ahead. But when presently we are 500 yards farther, this situation shall already have changed. Thus we must also judge the situation in its *possible* developments. In several languages the word *careful* is connected with the verb *see ahead*. A fore-seeing driver is a careful driver. And we need careful drivers on the roads. However, careful driving does not mean in itself *slow* driving, but so driving that in our judgment of the road situation the possible developments of this situation are also considered.

Thus the careful driver, to name only one characteristic, will use his brake infrequently on long distances on the open road, since by the regulation of his speed he has already foreseen in great measure the coming situation. This careful, judging perception of the road situation, which is only possible when we are bound actively in the situation with our whole body, is the nucleus of the pure psychological analysis of driving. It is much more important than

the so-called fast reaction time, which still remains as a requirement here and there as a remnant of function analysis from an earlier time.

Not fast reacting to a judged stimulus, but continuous fast realization of the meaning of the whole road physiognomy, is important in driving. Reacting is a category from an aging theory. The realizing of the meaning of the road situation is an act, an active partaking of the whole person in the traffic situation itself. The acts of steering and regulating my speed with my footpedals give the road situation for me that meaning which determines my place in this situation.

We Drive as We Are

From here it follows naturally that I drive precisely as *I am*. Not the faster or slower reacting to stimuli from a so-called outside world determine my style of driving, but the way in which I actively take part in the road situation, my binding to the agreements of the traffic society, my attitude toward the agreed meanings of the traffic signs, signals etc. and even the possibilities which arise for me as active member of this society yield the meanings that make it possible for me to reach my own traffic goal. In this style of driving, which determines whether or not I am a good driver, my whole personality is concerned.

This social attitude finds an adequate expression in the concept of responsibility. The careful, judging perception of the road situation in the activity of driving must be supported by a never slackening feeling of responsibility toward the other users of the road. Traffic is no game in which one may win or lose according to his skill and luck. The road situation is a part of a social world. The other users of the road are fellowmen, all with the same right to freedom of action within the boundaries of the traffic laws. Other automobiles are not things which move about on the road surface according to strictly determined rules, but, as it were, widened bodies of fellowmen who have their own freedom of action and, therefore, in the final instance, unpredictability. Precisely in order to make this degree of unpredictability as harmless as possible, the

traffic rules are set up so that, if everyone strictly obeys them, accidents will be limited to a minimum.

As a result of an analysis of the near-accidents of which I am aware, I have come to the conclusion that they happened because I did not take the *whole* traffic situation into consideration: I was paying attention only to a *part* of it. Paying attention to the whole situation has three aspects.

I. The most obvious aspect is the paying attention to the traffic situation as it is for *me*.

II. I must also take into consideration that a driver ahead has intentions of his own, and must try to see the highway also from his point of view.

III. But just as important is the need for me to realize what my own car and *my behavior* means for the *other users* of the road. Only he who keeps all three of these aspects of the situation in mind, while driving, can be called a safe and responsible driver.

As I have already said, I must drive, therefore, as much as possible in communicative bond with my fellow users of the road. This holds also in the requirements of a certain traffic etiquette. But especially the requirement that I adjust my driving to my own degree of proficiency. Not everyone can reach the same degree of virtuosity in his careful, judging perception. The feeling of responsibility requires, however, that in such a case I adjust my speed and procedure to the degree of my proficiency and take no risks that I can not carry through or that are beyond my driving capabilities. A good insight into himself is an absolute requirement for a driver with a feeling of responsibility. Hence my statement that a rather unskillful driver may still be permitted on the road if, on the basis of a strong feeling of responsibility, he adjusts his manner of driving to the degree of his proficiency. And, on the other hand, no driver with the same skill may be permitted to drive if his proficiency is not supported by a sufficiently developed social feeling of responsibility.

It would be extremely desirable if driving instructors received an education that would permit them to point out to students not only what they are doing wrong from the standpoint of traffic regulation, but also the dangers from the individual dispositions of their pupils, for example, from an insufficiently careful, judging perception.

What are the psychological causes of traffic accidents?

It is accepted that personal faults are to blame for 70 per cent of the accidents and technical lacks for only 30 per cent. An even greater percentage of the accidents attributed to technical lacks could be attributed to personal faults. The driver must often have known beforehand that he had faulty brakes. But also if these above figures actually represent the truth, there is reason enough to go further into the psychological analysis of accidents.

Unfortunately, the many objective conditions are lacking which would permit a pursual of this analysis with scientific exactitude. In the registration of accidents the data upon which such an analysis should be based are lacking. It is high time that a change be made here so that at least a part of the accidents could be investigated psychologically and statistically.

Therefore, what we will say here must be of a hypothetical nature in which we ourselves can not establish by computation what percentage of each of our factors is responsible for accidents.

Psychological Factors in Accidents

If we do not consider accidents caused by bodily defects and lack of routine, there are three large groups of factors to be pointed out which play an important role in the accidents caused by personal factors.

A. aptitude factors
B. bad disposition
C. faulty decisions of all kinds

Under the aptitude factors, those of an uneven temperament play a leading role. We do not wish to fall back on a theoretical contemplation here which would lead us too deeply into psychological

problematics. I will just remind you of the fact that by the idea rash, for example, a temperament characteristic is denoted. In a rash person the attraction of the goal—in our case a point on the road where we want to be—is not sufficiently checked by the resistances which must be overcome in order to reach this goal—in our case, for example, the traffic regulations. A rash driver has the tendency to move *too* directly toward his goal without regard for the route prescribed by the traffic rules. In a curve to the left, for example, he will take the left side of the curve instead of the right.

Rash people have by nature the tendency to break many traffic rules if that will bring them sooner to the desired goal. It is here again that only a well developed feeling of responsibility can correct such cases, because temperamental characteristics themselves are difficult to change. They lie deeply anchored in the biological core of the personality.

Another aptitude factor is that which stands in relationship with the tendency to panic. Panic is a deficiency of foreseeing perception. In panic the things in our world suddenly take on an entirely different meaning. They are experienced emotionally; they have an immediate, menacing character; and their subject is no longer actively involved in the traffic situation, but has himself withdrawn from the situation which he, as it were, rejects and which now masters him instead of his mastering the situation by the needed changes suggested by a foreseeing plan of operation. There are different degrees of the tendency to panic. Anyone will go into panic if the circumstances become more difficult than he can handle by virtue of his aptitudes, but that moment is reached sooner by one person than by another. The predisposition to panic is related to the manner in which the whole personality stands in, and in relation to, the world.

A third aptitude factor which can lead to personal mistakes in traffic is an innate weakness in the structuring of the field of attention. Sometimes this is connected with an innate intelligence defect. The possibility of quick realization of the traffic meaning of different situations is thus insufficient or entirely absent. These people come forth after an accident with the remark that they had not seen this or that. The opposing party then commonly answers: you

weren't paying attention—a pronouncement which represents very insufficiently what the case actually is.

A fourth factor is *suggestibility* in too great a measure. First, the behavior of other drivers or users of the road can influence our initiative till we stop making authentic decisions. In traffic jams, we see noteworthy examples of this. Second, the road physiognomy can exert in a certain sense a suggestive influence on the users of the road. It was shown in an American investigation that drivers on a winding road take more risks than on an open, straight road, while it should actually be the other way around. The dangerous road induces dangerous decisions.

Finally I shall list as the most important aptitude factor an undeveloped feeling of responsibility, when upon the basis of age and general development something more could be expected.

Psychopaths

We come here to psychopaths or psychopathic personalities with an underdeveloped social feeling. Also in people who are too young we find underdevelopment in this point. The driver's license is granted to 18-year-olds while the feeling of responsibility is often a late fruit in development. All sorts of other personal drives can be temporarily or permanently prevalent. Aggressive tendencies can try to find an outlet in a reckless forcing of the road situation. One drives as one is!

I visited a young psychopathic driver with strong aggressive tendencies who had wrecked his father's automobile because he had wanted to drive between another car and a tree. The opening proved too narrow. Personal irritability, not being able to bear having a car in front of us, and such attitudes not checked by a developed feeling of responsibility have caused many an accident. Also destructive tendencies and unconscious tendencies to self-destruction can lead to accidents.

As the second group of personal faults I named temporary disposition. Not every day do we have our *optimal energy* at our disposal; not every day are we just as well disposed to drive carefully and well. When emotional complexes occupy us consciously or un-

consciously, it is possible that the psychological conditions for a careful, judging perception are no longer present. We say then that we are preoccupied. Preoccupation is indeed enemy No. 1 of safe traffic. To be preoccupied means that inside ourselves we are living in another world than that of perception. We cannot drive completely adequately in the traffic world and at the same time be occupied inside ourselves with emotional complexes. It is unjust to say that if we demonstrate much routine we drive automatically or unconsciously. It would be absurd to say that we drive unconsciously. The accidents caused by half-asleep drivers prove the opposite. What is really true, but entirely different, is that we are commonly not in a reflective attitude while driving. If good drivers, we are 100 per cent with the objects of our traffic world, in communication with other users of the road, and with this being-consciously-with-the-objects we do not attend at all to our *reflective* consciousness.

Our movements are decidedly not reflexes as is so often heard. Our movements are extremely complicated answers to the traffic situation,—answers through which we finally realize the situation clearly and at the same time ask questions of the traffic situation whereupon we expect and receive an answer from the other users of the road. If we are preoccupied, we are in exactly the same situation in the car as when we speak with someone while in a state of preoccupation. We are not actually present; we give remote answers or answers that don't apply to the question. And especially where driving is concerned, we forget to attend to the traffic rules, the checking factors in respect to our attention on the goal. Driving becomes more primitive. We hold a silent monologue instead of a conversation with the traffic situation, and an accident is quite probable.

There are two sorts of being preoccupied. We may know, for one reason or another, that we are preoccupied, or we may not know it explicitly.

If we are conscious of our preoccupation, then our feeling of responsibility will perhaps require us to be extra careful in what we do. This forced regulation of attention, however, contains in itself a great danger, namely that we will be concerned with our regulation of attention instead of with the objects in the traffic

situation, just as the child who forces himself to listen to a dull teacher finally hears nothing more at all.

The 'Almost Accidents'

If we are preoccupied without explicitly taking it into account, then there is a great danger that the structuring of our field of action will be unclearly differentiated or insufficiently pregnant. Fortunately, in most cases we are warned in time by "almost" having an accident. These almost-accidents must always be a signal for the driver that something in his present disposition is not in order.

In such a case he must drive extra carefully until he is again entirely "in", that is, in the traffic situation. An unexplainable bad humor, a personal disappointment, a fight with wife or financée can all be causes of preoccupation against which we can arm ourselves in no other manner than by an extra carefulness. Often it suffices to drive slowly for several miles so that we have more time to realize what must be realized.

A preoccupation can also last, however, for days or weeks if it is the result of a neurotic condition in our psychic living. In such cases one should not drive at all or at least as slowly as possible.

One can also have a temporary bad disposition from overtiredness or too much alcohol. We know of all the accidents caused by half-asleep drivers. The question of over-tiredness is an interesting chapter in itself.

As to the cause of accidents by personal faults, common faulty decisions, it is impossible to assemble them all under a common generalization. We can, however, point out two sorts of mistakes.

The first concerns a faulty estimation of the time which an oncoming car must be allowed before reaching us, estimated from the moment that we have completely passed another car. From an American investigation it appeared that in fact 80 per cent of the drivers allowed for this one second or more. This second was named the Clearance Time by the researchers Forbes and Matson—the time that the driver considers permissible between his being completely past another car and the arrival of an oncoming car. Twenty per cent allowed less than one second and of these 10 per cent

operated definitely in a chance or luck zone with the result that the oncoming car did not have the whole road at his disposal.

One second was thus named by the writers a "common sense minimum."

There appeared to be no relationship with the speed. But on winding roads there was a tendency to allow less clearance time than on straight roads. The opener the road, the sooner one refused to pass, and in very bright weather this refusal was even sooner.

In refusing to pass it appeared that half of the cases were justified. The other half were thus mistaken, but that is a mistake which is naturally never fatal. On the other hand, the mistake of allowing too short a clearance time could have caused an accident.

Another mistake stems from the fact that while driving one must make suppositions over the situation which may present itself in the distance in a few seconds. Even though the traffic laws make the margin of unpredictability as small as possible, there always remains a little room for individual freedom. So an apparently still, parked car might suddenly come out of the row of parked cars, and we might notice this too late because we had classified this car beforehand as parked. It is not always easy to determine whether we can blame ourselves completely for these mistakes.

The Accident-Prone Type

It is well known from general accident psychology that a rather small group of persons are perhaps responsible for a great number of accidents. This makes it clear that it is possible to speak of an accident-prone type. Insurance companies would be quite happy to cross such real accident-prone people off their lists of clients. It would also be desirable to cross them off entirely from the list of road users. Here psychology can be of great service.

It has become clear that the function-analysis of driving can not be allowed to result in the fixing of a number of quasiexisting characteristics which a good driver must possess in sufficient quantity.

Naturally one man is handier than the other, realizes things more quickly, and has more presence of mind etc. But someone who

possesses all these characteristics in a lesser degree, but has a strongly developed feeling of responsibility, can compensate for many of his minus characteristics. From the proposition one drives as he is, it follows naturally that one will have to form a picture of the whole personality of the driver in order to be able to say anything essential about his style of driving.

In general it can be said that a socially mature personality with an even temperament and a reasonably sound intellect will be a good user of the road whatever his reaction-time or his "distributive" attention may be.

The reaction experiments from earlier time, in which the subject was considered as a reaction-machine, did not take into account the fact that in reality a stimulus receives its meaning from the whole situation in which the driver co-operates as creative subject.

At present, we examine the candidate in an entirely different way. We try to form a picture of the entire, peculiar way in which he is bound with the things of his world. And from this picture, then, an approximation must be made for the special case of fast traffic. It goes without saying that as few people as possible must be rejected—only the hopelessly irresponsible, the psychopaths, and those with constitutional deficiencies in their ability to realize the *road-meaning* must be refused permission to drive.

A Review: Statistical Techniques for the Traffic Analyst

F. HOUSTON WYNN
AND WILLIAM R. MCGRATH

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TRAFFIC engineering will reach another milestone when The Eno Foundation publishes the first book dealing exclusively with methods of statistical analysis for traffic engineers. The book, "Statistics and Their Application to Highway Traffic Analysis", is the work of two men, Dr. Bruce D. Greenshields, professor and executive officer in the Department of Civil Engineering at George Washington University, and Dr. Frank M. Weida, executive officer, Department of Statistics, also of George Washington University, edited by the Foundation Staff. During the last twenty years Dr. Greenshields has made numerous contributions to the field of traffic research. He is widely known among traffic engineers. Dr. Weida, a teacher and practicing statistician for many years, makes his first contribution to traffic engineers in this joint work.

The publication of a book of statistical methods for traffic engineers may surprise some, but to many the need has long been apparent. The existence of such a book foreshadows a scientific coming-of-age in this new profession and is sure to encourage and stimulate

bolder and more incisive research into the basic components of traffic structure—the driver, the vehicle, and the roadway.

The traffic engineer has widely diverse uses for statistical method in his work. While a single individual is seldom called on to explore every area of application, his understanding of basic statistical measures greatly simplifies the collection and analysis of data for any purpose.

Special Techniques Have Proved Value

It may be of interest to review briefly a few areas of traffic work in which special statistical techniques have already proved their worth. The problems of the traffic engineer, from the policy level down to the timing of a signal at an isolated intersection, respond readily to these analytical techniques that speed up the interpretation of data and insure reliable conclusions.

At the policy level an administrator may be concerned with "time-series" methods in forecasting future traffic increases, vehicle ownership ratios, annual mileage rates, accident rates, and other similar measurements. Good estimates of such factors are necessary to guide the planning and timing of new construction, route redevelopment, widening, or relocation, which require administrative decisions. While some of the information used may be available in handbook sources or come from service organizations, a complete understanding of the degree or "range of variability" in all such estimates lends valuable insight to decisions based on them.

In recent years the traffic engineer has been relied on to predict the vehicular volume that can be expected to use a tentatively selected route. New construction is exceedingly expensive and no longer can a route be established without first determining its foreseeable usefulness. To arrive at reasonably accurate answers to the many problems involved, the traffic engineer has developed interviewing techniques to determine the needs and desires of the motoring public through direct inquiry into the daily driving habits of the people themselves.

Not only does the analysis of information thus acquired involve extensive use of "correlation" techniques, but the proper selection of people or homes to be interviewed demands that "random sampl-

ing" techniques be used, based on "natural" or "ordinal" or "stratified" systems of selection depending on the amount of pertinent information already at hand. Careful use of these methods assures reliable results from a minimum of interviews.

The highway engineer who establishes the standards of geometric design for modern traffic facilities also calls on the traffic engineer for information concerning driver-behavior under a multitude of different conditions. The passing, spacing, and placement practices of drivers must be "correlated" with geometric factors such as lane width, sight distance, deceleration rates, exit and entrance capacity, curvature and grade, as well as with considerations of speed, lighting, weather condition, and such. The reduction of these collected behavior data to usable terms is a complex statistical operation. The resulting measures, in turn, may be interpreted in terms of "range" or "percentiles" which help the designer establish the proportion of road users who will be satisfied by designs of different quality.

The men engaged in the operation of a road network, either on a local or a state-wide basis, are interested in the practical vehicular capacity of the various components of their systems. So, too, is the designer of new facilities. Capacity is closely related to most of the factors of geometric design, lighting, weather and other conditions mentioned above. Much work has been and is being done to "correlate" these diverse factors by statistical means. Chapter V of the Greenshields-Weida book is largely devoted to illustrating some of the statistical work underway in these capacity studies. Ultimately, it is hoped, capacity studies may result in statistical formulas that may be used to establish quickly the approximate capacity of any roadway when certain basic values are known.

Statistical Treatment of Design Problems

Designers and operators of terminal facilities—parking garages, lots, loading docks, bus terminals, toll plazas, and the like—are faced with special problems that lend themselves to statistical treatment. The reservoir space needed to serve a parking garage, for instance, ought to be carefully considered to insure a minimum size of reservoir,

handling an optimum number of peak-hour vehicles, with a minimum number of employees. This complex statistical problem involves correlations that may best be solved by "mathematical models." A somewhat less complex situation develops in calculating the number of change-booths and amount of reservoir space required at toll plazas.

Still other design problems involve physical and psychological factors which may be measured and analyzed through statistical techniques. Experiments are constantly being made to improve the legibility and meaning of sign legends, to develop attention-compelling qualities in signs, signals and other devices, to determine the most desirable color combinations for signs and devices, and to discover the most effective locations for their placement. In these studies, especially, the aim is to accommodate not the *average* driver, but *all* drivers on the road, so far as is practical. A high "percentile" value is usually the guide sought by the designer.

Every practicing traffic engineer keeps, or has access to, an accident record file. Every serious automobile accident that occurs within his sphere of responsibility, whether or not it results in death or injury, is represented in this file in the form of a standard report. In most instances supplementary reports submitted by investigating officers add to the available information. These data lend themselves to several forms of statistical analysis. Future trends of over-all accident occurrence are calculated by means of "time-series" techniques.

On the other hand, "variance analysis" and "correlation" analysis" are employed to evaluate a handful of mishaps occurring at a single location over a period of months or years. While some of the techniques of accident analysis have been set forth in another report,[1] recent advances in statistical techniques promise to make the evaluation of accident data a much more valuable phase of traffic engineering than it has been hitherto. These techniques will be used by traffic engineers to evaluate proposed remedial measures quickly and accurately from a minimum number of accident reports.

The field of driver testing and the re-examination of accident-prone drivers has not yet come into its own as a generally accepted

[1] "The Use of Traffic Accident Records," The Eno Foundation, 1947.

means of eliminating the unfit and the unreliable from the driver's seat. Encouraging progress is being made, however, and there is little doubt that the techniques eventually employed will be largely those of the statistician.

Techniques at the Operational Level

At an operational level, the traffic engineer finds need for a great diversity of statistical techniques, not all of them simple. He must measure the effects of new control devices or regulations in terms of congestion and delay and establish the "significance" of such differences as have come about. Very often the success or failure of a new expedient is not apparent to the casual observer, but whether the measure stands or is voted down at the next council meeting may depend upon the statistical evidence of a carefully analyzed before-and-after study.

Traffic counting is perhaps the most basic and routine function of the traffic engineer's office. Because it is so basic there is a lot of it to do. A carefully designed system of short-time sample counts can often accomplish nearly as good results as a more extensive operation consisting of long-time counts. Use of the correct statistical measures will show clearly the "degree of confidence" that can be placed in the work. The short count, coupled with a statement of its statistical stability is in fact more meaningful in the hands of an analyst than a much longer count not so qualified.

The outstanding feature of statistics is that it affords means of estimating general laws of behavior of measurable attributes. Inductive reasoning—from the particular to the general—is safeguarded from error through the use of this unique branch of mathematics which furnishes positive statements of the confidence that may be placed in the results so obtained. Dr. Weida and Dr. Greenshields point out in Chapter I that scientific traffic regulation and planning must be based on increased knowledge of traffic behavior. Statistics is a scientific tool designed to aid in securing such knowledge. The authors proceed from these premises in the introductory chapter describing and defining the nature of statistics and its applicability to traffic problems.

Going beyond mere description, the first chapter surveys problems of experimentation and presents a philosophy to be followed in any research study. Stress is placed on the importance of good experimental design, proper analysis, and adequate reporting.

The first step in experimental design is to answer the question, "Is the problem solvable by statistical methods? If so, what methods are applicable, what variables need to be measured, how much data are needed, and how best to obtain the needed data?" The best available means of measurement must be selected and used to eliminate possible sources of bias and error. For statistical applications thorough knowledge of sampling methods will be required at this state. The required size of sample must be carefully determined. It must be large and detailed enough to assure the certainty and usefulness of the results, yet as small and as inexpensive as possible to preserve the feasibility of the project.

In the analysis care must be taken to apply statistical techniques accurately and without bias. The authors state that "In all cases it must be demonstrated that the statistical law of behavior to be used agrees with actual behavior." It is also reiterated that the report must be thorough and unprejudiced. It must present all the findings, negative as well as positive. Loss of valuable information through careless reporting must be avoided.

Data Must Be Readily Understood

A basic problem in statistical work is presentation of data in readily understandable form. This demands compactness to bring meaning within easy grasp combined with retention of significant detail. In Chapter II the authors discuss the frequency distribution and the numerous summarization values that may be used to describe and characterize a set of data.

The very picture presented by a frequency distribution, either in graphical or tabular form, furnishes considerable insight into the nature of the variable which has been measured. Proceeding from this broad picture to finer details in specific cases—data concerning vehicle speeds for example—the distribution shows the range for the slowest to the fastest. It shows what proportions travel above or

below given speeds and frequencies in various speed classes. The shape of the distribution may be explored and related to similarly shaped curves whose mathematical expressions might be taken as estimates of the laws governing the observed distribution.

Further analysis and characterization is possible through the use of single values to describe in certain fashion the entire set of data. The authors present with detailed derivation several averages: the arithmetic mean, mode, median, geometric mean and harmonic mean. Each of these averages, used as prescribed in the chapter, serves to characterize the central tendencies of the data. The relationships between these sample averages and corresponding values derivable from mathematical distribution functions are described. The dispersion of the data may also be characterized by averages of differences; such as average deviation, standard deviation, moments, and the central harmonic mean. These averages are of differences developed fully and related to their mathematical counterparts.

In Chapter III the authors develop the basic distributions, which grow directly out of the mathematics of probability. Briefly these distributions are:

(a) *Binomial*—the expression for the probability of an event occurring any stated number of times in given set of trials.

(b) *Normal*—a simplified approximation of the binomial applicable in instances when the number of trials is great and the chance that the event will occur in a given trial is nearly equal to the chance it will not occur.

(c) *Poisson*—an exact expression for the binomial in instances when the number of trials is infinite and the chance of the event occurring in a given trial is extremely small.

In addition to these basic distributions the authors describe briefly two of the numerous other specialized distributions which occur in statistics:

(1) *Multinomial*—pertains to the probability involved when there are more than two classes into which a particular event may fall.

(2) *Hypergeometric*—deals with conditions under which the probability of occurrence of a given event does not remain constant throughout the set of trials.

The derivations of the characterizing and summarizing values that may be used to describe the basic distributions are developed fully. The relationships between the distributions and between theoretical and experimental distributions are also discussed.

After thoroughly developing the basic distributions, the authors shift attention to the situation when it is desired to test the relationships between more than one variable. The methods of correlation are described as the means by which this is accomplished. The methods of determining the best regression equations or lines to describe the relationships are shown. Computable measures of the adequacy and reliance of such equations and lines are derived.

Sampling Theories Presented

Knowledge and understanding of the sampling theories presented in Chapter IV, and those portions of Chapter III which also apply, are essential to the experimenter who desires to go beyond his data in order to make generalized statements arrived at by inductive reasoning.

Random sampling receives first attention in this chapter since randomness is an essential attribute of samples which are to receive statistical treatment. Modifications of this basic requirement are permissible to permit stratification or selection but even then at some point in the process randomness must be the controlling feature. In this connection it is important to note that randomness applies to the method of selection rather than the sample itself. Any conceivable set of data constituting a sample could possibly be arrived at in random selection and all such sets must have equal chance of being selected to satisfy the requirements.

The chapter describes further the sampling distributions that affect the computable summarization values which may occur in any sample. It is through these distributions that "confidence limits" covering the true values of variables being measured are established. These distributions also enable the experimenter to guarantee, with a predetermined level of probable accuracy, the validity of his results. The methods of determining the significance of apparent differences or similarities between different samples, or between

experiment and theory, are shown. The relationships between apparently correlated variables can be studied and the reality or absence of the correlation established.

Thus the material of this chapter furnishes the traffic analyst with means of discovering laws and true measures of traffic behavior and of explicitly stating on a mathematical basis the degree of confidence he has in his results.

The final chapter is devoted to illustrating practical applications of statistical methods to highway traffic problems. The authors have concentrated their effort on the application of the Poisson distribution to vehicle spacings in the traffic stream. The purpose of this application is discovery of laws of traffic behavior as they affect highway capacity. The development of this study is thorough and has in fact been carried beyond points previously published. The method of fitting a theoretical distribution to an experimental distribution is thoroughly demonstrated.

Unfortunately, the detail required to develop this distribution severely limited the space available to the authors for other examples. A short description of the application of the Poisson distribution to accident occurrence is presented. There is also a discussion regarding necessary sample sizes in vehicle occupancy and speed studies.

Dr. Weida and Dr. Greenshields have developed in detailed mathematical form standardized statistical methods that may be useful in solving traffic problems. Presenting derivations and explanations of meanings of these statistical methods is the major effort the authors undertake in this book. As a result, several chapters of the book are devoted to highly technical exposition.

This book is of undoubted importance to traffic research workers who must know the underyling bases of all statistical applications they may employ in their studies. Increased practical application of these purely mathematical forms will no doubt be greatly simplified and improved with experience and further accumulation of empirical data.

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